DOCUMENT RESUME

ED 201 483 SE 034 694

AUTHOR	Morgan, Walter; And Others
TITLE	K-12 Science Curriculum Guide.
INSTITUTION	Upper Arlington City School District, Ohio.
PUB DATE	80
NOTE	1,101p.
AVAILABLE FROM	Assistant Superintendent for Curriculum, Instruction and Planning, Upper Arlington City School District, 1950 North Mallway, Upper Arlington, OH 43221 ($25.00 plus postage).
EDRS PRICE	MF08/PC45 Plus Postage.
DESCRIPTORS	Behavioral Objectives; *Cognitive Processes; Curriculum Development; Curriculum Guides; *Elementary School Science; Elementary Secondary Education; Science Curriculum; Science Education; *Secondary School Science; Student Evaluation; *Units of Study

ABSTRACT

This K-12 science curriculum guide includes the following: (1) a philosophy statement; (2) related district educational goals; (3) components and major objectives; (4) scope and sequence; (5) instructional objectives; (6) guidelines for the evaluation of student performance; (7) instructional units; (8) curriculum guide evaluation forms; and (9) a bibliography for the preparation of the guide. The philosophy and related district educational goals provide the framework for the specific contributions of the science discipline while the components and major objectives outline the fundamental elements of science around which the curriculum can be organized. The content of science is the vehicle for the achievement of the objectives under each component and the scope of this content is embodied in a three-dimensional matrix in a scope, sequence, and instructional objectives chart. One dimension of this matrix is delineated by the processes of science, the second by the concepts, and the third by the units of instruction. The intercept of these three axes defines a cell in which one or more instructional objectives is stated, and establishes the lower limits of student achievement. Each instructional unit includes a content outline, objectives and suggested activities, resources, and exemplary activities, and a sample evaluation instrument or technique. (GS)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED201483

U S DEPARTMENT OF HEALTH.
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
JAMES S. LANTZ

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

K-12 SCIENCE CURRICULUM GUIDE

UPPER ARLINGTON CITY SCHOOLS

Homer F. Mincy, Superintendent

1980

SE034 694

TABLE OF CONTENTS

Page

Contributors to the K-12 Science Curriculum Guide i

Introduction ii

Philosophy 1

Related District Educational Goals 2

Components and Major Objectives of the K-12 Science Curriculum 4

Scope, Sequence, and Instructional Objectives -- Processes (insert)

Scope, Sequence, and Instructional Objectives -- Concepts (insert)

Evaluation of Student Performance 5

Instructional Units (Including Suggested Activities and Resources)

K (pink)
1. Pattern Blocks 11
2. Mirror Cards 16
3. Changes 21
4. Zoo Animals 26
5. Light and Shadows 31

6. Attribute Games and Problems 36
7. Eggs and Tadpoles 41
8. Geo Blocks 46

1 (green)
1. Clay Boats 51
2. The Solar System 56
3. Energy and Magnetism 61
4. Animals and Brine Shrimp 66
5. Primary Balancing 71

6. Tangrams 79
7. Mobiles 87
8. Spinning Tables and Machines 92

2 (gold)
1. Green Plants: Growing Seeds 97
2. Geology: Rocks and Minerals 102
3. Air, Weather, and Seasons 108
4. Butterflies and Moths 115
5. Exploration of Outer Space 120

6. Match and Measure 131
7. Energy and Static Electricity 137
8. Geo Blocks 142

Instructional Units (Cont.) Page

3 (blue)
1. The Earth's Features 147
2. Energy and Conservation: Electricity. . . . 153
3. Astronomy: Solar System and Galaxies . . . 161
4. Simple Machines and Structures 172
5. Animals and Animal Tracks 180

6. Drops, Streams, and Containers 185
7. Mirror Cards 193

4 (yellow)
1. Prehistoric Life 198
2. Geology: Rocks and Minerals 204
3. Mystery Powders and Solutions 215
4. Energy: Magnetism and Sounds 221
5. Insects and the Behavior of Mealworms . . . 230

6. Conservation and Stream Tables 235
7. Peas and Particles 241

5 (pink)
1. Electricity: Batteries and Bulbs 246
2. The Individual and the Environment 251
3. Weather and Seasons 259
4. Light and Optics 268
5. Gases and Air 274

6. Water Flow 281
7. Aviation and Aerodynamics 286

6 (green)
1. Outdoor Education 293
2. Oceanography 298
3. Astronomy: Beyond the Solar System 306
4. Small Things and Microgardening 315
5. Geology 325

6. Chemistry and Kitchen Physics 336
7. Solar Energy and Conservation 342

7 (gold)
Life Science
1. Classification 350
2. Structure of Organisms 357
3. Activities of Organisms 366
4. Ecology 372
5. Heredity and Evolution 384

6. Treatment of Data 406

Instructional Units (Cont.) Page

8 (blue) Earth Science

1. Using Data 415
2. Astronomy 432
3. Geology 442
4. Meteorology 455
5. Oceanography 467

6. Energy 481
7. Discovering With Instruments 488

9 (yellow) Physical Science R

1. Radiant Energy 502
2. Magnetism and Electricity 516
3. Motion 525
4. Physical Properties of Matter 536
5. Chemical Properties of Matter 548

6. Nuclear Energy 561
7. Mechanics 567

9 (pink) Physical Science S

1. Radiant Energy 575
2. Magnetism and Electricity 586
3. Motion 600
4. Physical Properties of Matter 616
5. Chemical Properties of Matter 628

6. Nuclear Energy 643
7. Mechanics 649

10, 11, 12 (green) Biology: Descriptive

1. Ecology and the Biosphere 661
2. Diversity Among Living Things: Classification of Protista, Plants, and Animals 667
3. Within the Organism: Anatomy and Physiology . 674
4. Energy and Life: Photosynthesis and Respiration 683
5. Continuity of Life: Reproduction, Heredity, and Evolution 695

6. Patterns in the Biosphere: Terrestrial and Marine, Past and Present 711

Instructional Units (Cont.) Page

10, 11, 12 (gold) Biology: Investigative
1. Ecology and the Biosphere 717
2. Diversity Among Living Things: Classification of Protista, Plants, and Animals 727
3. Within the Organism: Anatomy and Physiology . 734
4. Energy and Life: Photosynthesis and Respiration 742
5. Continuity of Life: Reproduction, Heredity, and Evolution 749
6. Patterns in the Biosphere: Terrestrial and Marine, Past and Present 758

10, 11, 12 (blue) Biology: Adjusted
1. Ecology and the Biosphere 767
2. Diversity Among Living Things: Classification of Protista, Plants, and Animals 774
3. Within the Organism: Anatomy and Physiology . 781
4. Energy and Life: Photosynthesis and Respiration 788
5. Continuity of Life: Reproduction, Heredity, and Evolution 795
6. Patterns in the Biosphere: Terrestrial and Marine, Past and Present 802

10, 11, 12 (yellow) Chemistry R
1. Fundamental Concepts 807
2. Classification of Elements 812
3. Chemical Formulas and Equations 820
4. Measurement 825
5. Physical States of Matter 835
6. Solutions and Their Properties 843
7. Chemical Reactions 849
8. Descriptive Chemistry 854

10, 11, 12 (pink) Chemistry S
1. Fundamental Concepts 861
2. Classification of Elements 868
3. Chemical Formulas and Equations 877
4. Measurement 882
5. Physical States of Matter 883
6. Solutions and Their Properties 891
7. Chemical Reactions 898
8. Descriptive Chemistry 907

11, 12 (green) Advanced Chemistry
1. Biochemistry 916
2. Organic 923

Instructional Units (Cont.) Page

11, 12 (gold) Physiology
1. The Whole Body 930
2. Body Framework 940
3. Nervous System 948
4. Digestive System 957
5. Respiratory System 966
6. Circulatory System 972
7. Excretory System 983

11, 12 (blue) Physics R
1. Measurement and Data Handling 990
2. Mechanics, Energy, and Kinetic Theory . . . 991
3. Waves and Wave Phenomena 1001
4. Electricity and Magnetism 1012

5. Energy, the Environment, and Our Economy . . 1020

11, 12 (yellow) Physics S
1. Measurement and Data Handling 1021
2. Mechanics, Energy, and Kinetic Theory . . . 1029
3. Waves and Wave Phenomena 1035
4. Electricity and Magnetism 1043

5. Energy, the Environment, and Our Economy . . 1053

Curriculum Guide Evaluation Forms (2)

Bibliography for the Preparation of the Curriculum Guide

CONTRIBUTORS TO THE K-12 SCIENCE CURRICULUM GUIDE

Project Directors

Walter Morgan	Elementary Science Coordinator
Gary L. Sweitzer	Secondary Science Coordinator

Format and Objectives Committee

Dave Heigle
Walter Morgan
Peggy Sheets
Gary Sweitzer

Major Contributors of Objectives and Instructional Units

Becky Ballard
Marge Bennett
Nancy Boreske
Emma Jane Bowman
Terry Brooks
Joe Caruso
Dave Churchman
Ellen Clark
Anna Marie Converse
Sue Cook
Bill Coover
Sharon Corbett
Walt Corbett
Barbara Courtright
Ron Curnutte
Mark Davis
Midge Detwiler
Rosalie Dryden
Myra Dull
David Evans
Carolyn Farnsworth
Celeste Fender
B.J. Ferriel
Melissa Frank
Peggy Glenn
Jo Graft
Howard Grimm
Jim Hamilton
Jan Harris
Frank Hatcher
Dorothy Herbert
Becky Hertler
Phil Hord
Vickie Houser
Jackie Hutchings
Corky Jackson
Mike King
Jill Kuyper
Jim Lambourne
Sonnie Lawrence
Susan Leach
Ruby Leininger
Carole Listiak
Kathy Main
Mike Matthaes
Fran McCullough
Ray McCutcheon
Jon McQuillin
Sylvia Miller
Kitty Mirick
Walt Morgan
Paul Noll
Nancy Parks
Doe Peterson
Susie Preston
Judy Prokupek
Laura Rieman
Margaret Royce
Mary Salser
Roger Santille
Lu Sarver
Steve Scarpitti
Sallie Schleder
Marilynn Schwenk
Kathy Seall
Peggy Sheets
Wanda Short
Cheri Slinger
Carol Smith
Carol Stewart
Jean Stough
Gary Sweitzer
Linda Taylor
Loren Van Deusen
Laura Vaughan
Marilyn Waldsmith
Jackie Ware
Karen Wilcox
Claudine Williams
Louise Williams
Tom Yarletts
Esther Yarrington

INTRODUCTION

The information contained in the K-12 Science Curriculum Guide includes the following:

- Philosophy
- Related District Educational Goals
- Components and Major Objectives
- Scope, Sequence, and Instructional Objectives
- Evaluation of Student Performance
- Instructional Units (including outlines, objectives and suggested activities, resources, exemplary activities, and sample evaluations)
- Curriculum Guide Evaluation Forms
- Bibliography for the Preparation of the Curriculum Guide

Each discipline contributes a distinctive part to the general education of students at the various levels of instruction. The philosophy and the related district educational goals provide the framework for the specific contributions of the discipline of science. It is this framework that governs the selection of content and learning experiences that helps to comprise a curriculum.

The components and major objectives outline the fundamental elements of science around which a curriculum can be organized. These elements include the nature of science and its values, the processes and concepts of science, science and society, interest, and manipulative skills.

The content of science is the vehicle for the achievement of the objectives under each component. The knowledge explosion precludes covering all of the content of science, and mandates the establishment of a scope of content for the discipline. Considering the needs of the learner, the nature of the learning process, the demands of a technological culture, and the content of the discipline of science, this scope is embodied in a three-dimensional matrix in the scope, sequence, and instructional objectives section.

One dimension of this matrix is delineated by the processes of science, the second by the concepts, and the third by the units of instruction. This matrix is presented as two separate charts, one for the processes of science and one for the concepts. The intercept of these three axes defines a cell in which one or more instructional objectives is stated, and establishes the lower limits of student achievement. Given the developmental nature of learning, these instructional objectives embody a developmental sequence of learner outcomes throughout the curriculum. The objectives are keyed to the units of instruction, using a simple number key. The objectives do not represent all of the possible instructional outcomes from any given unit, but rather a core that all students should attain. In grades nine through twelve, where more than one course exists, the units, scope, sequence, and instructional objectives represent the core for that area of instruction.

The evaluation of student performance section presents an overview of the evaluation procedure as a tool for improving the teaching-learning process. This section enumerates various purposes for evaluation, methods of obtaining information, a classification of evaluative procedures, and guidelines for the recording and reporting procedures. Specific examples or suggested evaluative procedures are included in each unit. Teachers are encouraged to evaluate all components of the science discipline as appropriate, bearing in mind that evaluative procedures often become the implicit curriculum.

The next section contains the instructional units, with the first group being the core units and the second group being optional. The instructional units include an outline, objectives and suggested activities, resources, exemplary activities, and sample evaluations. The outline represents the suggested content to be used as a vehicle for the achievement of the instructional objectives, and provides a core of fundamental knowledge in the discipline of science. Teachers should exercise instructional flexibility in implementing the scope and sequence of this content to match the needs and developmental stages of the learners. The objectives, suggested activities, and resources present instructional materials that are in keeping with the philosophy that science is an ever-changing method of inquiry. The exemplary activities are presented as models of instructional procedures that serve well in the classroom in terms of student involvement and success. The sample evaluation instruments are presented for teacher consideration as one aspect of the evaluative procedure, and are not intended as instruments to evaluate all areas of student performance.

The final section of the guide contains an instrument for the evaluation of the guide itself. The guide is a tool to aid teachers in implementing instructional procedures that assist students in attaining the objectives of the science curriculum and the related district goals. Any suggestions that will improve the effectiveness of this guide will be greatly appreciated.

PHILOSOPHY

Education of the individual members of a democratic society becomes increasingly important as that society becomes more complex. This education will be successful only if each individual can be brought to a concept of self-realization involving a positive attitude toward learning. The attainment of this self-concept depends upon the availability of a variety of modes of learning so that individuals can attain success in the mode in which they learn best.

A study of science can provide experiences wherein learners play an active role in the development of their attitudes and critical thinking. Science is a flexible, ever-changing method of inquiry that lends itself to the formulation of highly individualized learning and reasoning strategies that have application far beyond the confines of the discipline.

RELATED DISTRICT EDUCATIONAL GOALS

As educators in Upper Arlington, we strive to attain a marked degree of success for each of our students in all of the educational goals. As science educators, however, we acknowledge the specific significance we place upon some particular objectives as we teach the science education curriculum. The objectives listed below receive emphasis at particular grade levels in the science education subprogram.

DEVELOPMENT OF SKILLS

DEVELOP SKILLS IN READING, WRITING, SPEAKING, AND LISTENING

A. Develop ability to communicate ideas and feelings effectively.

LEARN HOW TO EXAMINE AND USE INFORMATION

A. Develop ability to examine constructively and creatively.
B. Develop ability to use scientific methods
C. Develop reasoning abilities.
D. Develop skills to think and proceed logically.

GAIN A GENERAL EDUCATION

A. Develop background and skills in the use of numbers, natural science, mathematics, and social sciences.
B. Develop a fund of information and concepts.
C. Develop special interests and abilities.

LEARN ABOUT AND TRY TO UNDERSTAND THE CHANGES THAT TAKE PLACE IN THE WORLD

B. Develop an awareness and the ability to adjust to a changing world and its problems.
C. Develop understanding of the past, identify with the present, and be able to meet the future.

DEVELOPMENT OF PERSONAL AND SOCIAL VALUES

DEVELOP A DESIRE FOR LEARNING NOW AND IN THE FUTURE

A. Develop intellectual curiosity and eagerness for lifelong learning.
B. Develop a positive attitude toward learning.
C. Develop a positive attitude toward continuing independent education.

DEVELOP PRIDE IN WORK AND A FEELING OF SELF-WORTH

A. Develop a feeling of student pride in his achievements and progress.
B. Develop self-understanding and self-awareness.
C. Develop the student's feeling of positive self-worth, security, and self-assurance.

DEVELOP GOOD CHARACTER AND SELF-RESPECT

A. Develop moral responsibility and a sound ethical and moral behavior.
B. Develop the student's capacity to discipline himself to work, study, and play constructively.
C. Develop a moral and ethical sense of values, goals, and processes of free society.
D. Develop standards of personal character and ideas.

DEVELOPMENT OF SKILLS

GAIN INFORMATION NEEDED TO MAKE JOB SELECTIONS

A. Promote self-understanding and self-direction in relation to student's occupational interests.

DEVELOP SKILLS TO ENTER A SPECIFIC FIELD OF WORK

B. Develop an awareness of opportunities and requirements related to a specific field of work.

DEVELOPMENT OF PERSONAL AND SOCIAL VALUES

LEARN TO RESPECT AND GET ALONG WITH PEOPLE

A. Develop appreciation and respect for the worth and dignity of individuals.

C. Develop a cooperative attitude toward living and working with others.

COMPONENTS AND MAJOR OBJECTIVES OF THE
K-12 SCIENCE CURRICULUM

I. The Nature of Science and Its Values

   A. The student understands that scientific knowledge is empirical, historic, and tentative.

   B. The student demonstrates a desire to search for data, demand verification, respect logic, and consider premises and consequences.

II. The Processes and Concepts of Science

   A. The student develops an understanding of the basic processes of science such as observing, classifying, and measuring; the intermediate processes such as questioning, predicting, and inferring; and the advanced processes such as experimenting and formulating models.

   B. The student develops an understanding of the major science concepts and can apply these concepts in interacting with his daily life situations and environment.

III. Science and Society

   A. The student realizes the distinctions between science and technology and is aware of the overlap and the interrelationships that exist between the two.

   B. The student becomes aware that science and technology have a real and direct effect on the lives of each individual and his environment.

IV. Interest

   A. The student feels and expresses a satisfactory level of interest in science and shows a preference for scientific explanations.

   B. The student becomes aware of science-related vocations and avocations.

V. Manipulative Skills

   A. The student develops numerous manipulative skills associated with a laboratory science.

   B. The student becomes familiar with the use of scientific instruments.

This was developed using a working document titled "Program Objectives and Scientific Literacy" which appeared in Prism II, volume 2, numbers 3 and 4, Center for Unified Science Education, 1975.

K-12
INSTRUCTIONS FOR ASSEMBLING CONCEPT SCOPE AND SEQUENCE CHART

1. Overlap pages so that all vertical and horizontal lines match continuously according to the pattern below.

2. Trim page edges as necessary.

1-a	1-b	1-c	1-d	1-e
2-a	2-b	2-c	2-d	2-e
3-a	3-b	3-c	3-d	3-e

	CAUSE-EFFECT A relationship of events that substantiates the belief that "nature is not capricious." Once established, it enables predictions to be made.	**CHANGE** Everything is in the process of becoming different or something else. The rate at which it happens varies from very fast to very slow so that it may be unnoticed in these extreme cases. May involve several stages or mechanisms.
LEVEL; UNIT **K** 1. Pattern Blocks 2. Mirror Cards 3. Changes 4. Zoo Animals 5. Light and Shadows 6. Attribute Games and Problems 7. Eggs and Tadpoles 8. Geo Blocks	(3, 5) Identifies factors that affect change. (7) Identifies environmental conditions that are associated with the care and development of frogs.	(3) Identifies different kinds of changes. (3, 5, 7) Notes that change occurs through time. (7) Describes similarities and differences that exist in the various stages of frog development.
1 1. Clay Boats 2. The Solar System 3. Energy and Magnetism 4. Animals and Brine Shrimp 5. Primary Balancing 6. Tangrams 7. Mobiles 8. Spinning Tables and Machines	(1, 2, 3, 5, 7, 8) Identifies variables that can cause movement of matter. (4) Identifies environmental conditions that are associated with the care and development of brine shrimp.	(4) Notes that change occurs through time.
2 1. Green Plants: Growing Seeds 2. Geology: Rocks and Minerals 3. Air, Weather, and Seasons 4. Butterflies and Moths 5. Exploration of Outer Space 6. Match and Measure 7. Energy and Static Electricity 8. Geo Blocks	(1, 3) Identifies environmental conditions associated with the growth of green plants and changes in weather.	(1, 3, 4) Notes that changes which occur through time may follow a pattern. (2) Changes in time may accompany changes in the properties of objects.
3 1. The Earth's Features 2. Energy and Conservation: Electricity 3. Astronomy: Solar System and Galaxies 4. Simple Machines and Structures 5. Animals and Animal Tracks 6. Drops, Streams, and Containers 7. Mirror Cards	(1) Becomes aware of the forces in nature that cause the various geologic features of the earth. (4) Uses simple machines to make work easier. (6) Manipulates variables to produce different effects in liquids. (7) Learns that certain manipulations of mirrors result in particular behaviors of light.	(1) Considers the earth's features as being in a state of constant gradual change.
4 1. Prehistoric Life 2. Geology: Rocks and Minerals 3. Mystery Powders and Solutions 4. Energy: Magnetism and Sound 5. Insects and the Behavior of Mealworms 6. Conservation and Stream Tables 7. Peas and Particles	(3) Predicts the behavior of such materials as food coloring, iodine, and vinegar in various situations involving liquids and powders. (6) Identifies how running water affects the earth's surface.	
5 1. Electricity: Batteries and Bulbs 2. The Individual and the Environment 3. Weather and Seasons 4. Light and Optics 5. Gases and Air 6. Water Flow 7. Aviation and Aerodynamics	(4) Identifies the causes of different optical effects resulting from light passing through the atmosphere. (5) Identifies variables that are related to an investigation of gases. (6) Demonstrates an understanding of the effect of water, air pressure, and gravity on the water flow system. (7) Investigates the design components that contribute to paper airplane flight.	

1-6

UPPER
K-12
Scope, Sequence,

CYCLE The apparent pattern in which certain events or conditions seem to be repeated at regular intervals or periods.	**ENERGY** That which enables something to be moved or changed.	**MATTER** Any material that has mass and occupies space. It exists in the form of units which can be classified at different levels of organization.
(7) Observes the stages of development in a biological cycle.		
	(8) Determines the advantages of using simple machines and is aware of the basic relationship among energy, force, and machines.	(1) Manipulates the shapes of matter to maximize one property related to the space it occupies, i.e., buoyancy.
(1, 3) Becomes familiar with the cycle of seasonal changes and their effect upon green plants. (3, 4) Notes that the pattern of change through time repeats itself in the life of moths and butterflies and in the seasons of the year.	(1) Identifies the sun as a necessary source of energy for plant growth. (7) Becomes aware of some effects on matter of sound and static electricity.	(2) Recognizes properties of rocks and minerals such as length, area, volume, texture, hardness, luster, and color.
	(2, 4) Investigates how energy is produced, transferred, and transformed.	(2) Deduces that matter has different electrical properties. (3) Understands the major characteristics of stars and can recognize some constellations. (6) Investigates liquid flow, layering, surface tension, and drops.
(5) Distinguishes among the egg, larval, papal, and adult stages of a mealworm.	(4) Recognizes that sound is a form of energy and is associated with the vibration of matter. (4) Recognizes properties of sound as perceived by humans, e.g., loudness, pitch, quality.	(2) Reports characteristics of different kinds of rocks and minerals. (3) Identifies the basic properties of liquids, i.e., surface tension, definite volume but no definite shape, and density.
(2) Identifies recycling as a means for the reprocessing of used materials. (3) Identifies the stages and order of progression of the events in the water cycle and seasonal changes.	(1) Identifies insulators and conductors and constructs circuits that illustrate the basic differences between parallel and series circuits. (4) Becomes aware that light is reflected, refracted, absorbed, and transmitted to different degrees depending upon the physical properties of the materials involved.	(5) Cites characteristics that support the idea that air is matter. (5) Compares the properties of the three physical states of matter.

RLINGTON CITY SCHOOLS
Science Curriculum Guide
and Instructional Objectives—Concepts
1980

1-C

EQUILIBRIUM	EVOLUTION	FORCE
That state of affairs in which changes occur in opposite directions, exist, or happen at equal rates or are of the same magnitude.	A series of slow changes that can be used to explain how something got to be the way it is or what it might become in the future. Generally regarded as going from simple to complex.	A push or pull.
(5) Demonstrates knowledge of primary balancing by describing and being able to apply such basic concepts and terms as balanced, unbalanced, fulcrum, load, and weight. (5, 7) Given situations involving objects, evaluates systems not in balance and demonstrates procedures necessary to achieve a balance.		(3, 8) Becomes aware of forces due to magnets and spinning objects.
	(1, 2) Becomes aware that the environment is constantly changing and that species may undergo changes to adapt to the environment.	(5) Becomes aware that a consideration of gravity is part of space travel and investigates the various means through which man explores outer space.
	(3) Indicates the developmental stages and evolution of a star.	
	(1) Identifies the life forms that existed during specified time periods and indicates that living things change through time.	(4) Recognizes magnetism as one type of force.
(2) Identifies human behaviors that upset the balance of nature.		(1) Becomes aware that magnetic force is associated with electricity. (7) Identifies forces associated with heavier than air flight.

1-d, e

MODEL A more or less tentative scheme or structure which seems to correspond to a real structure, event, or class of events and which has explanatory value. Includes the ideas of theory and scale.	**PATTERNS** The belief that there is either order in nature or that man is able to impose order is expressed according to various schemes. Includes the idea of symmetry.	**ORGANISM** An open dynamic system which is characterized by the processes of life.	**PROBABILITY** The relative certainty (or lack of it) that can be assigned to certain events happening in a specified time interval or sequence of other events.
	(1, 2, 6, 8) Sees patterns with objects and is able to manipulate objects to form new and predetermined patterns. (1, 2, 6, 8) Identifies existing symmetry in the arrangement of objects and distinguishes between differences and similarities in patterns.	(4) Notes differences in structure of various animals. (7) Notes structural changes that occur during the developmental stages of a frog's life.	
(2) Becomes familiar with the model of the solar system and the names of all nine planets.	(6) Becomes aware of congruent patterns.	(4) Notes structural changes that occur during the developmental stages of a brine shrimp's life. (4) Notes differences in structures of various farm animals.	
(5) From a picture, makes a model of the solar system which reflects the correct position, color, and relative size of the planets. (8) Given a variety of photos of a structure, constructs a model using blocks.	(8) Maps a pattern and constructs a model that is bilaterally symmetrical.	(1, 4) Identifies certain conditions that are necessary to maintain life processes.	
(5) Manipulates various kinds of maps and models used to represent surface features of the earth. (5) Constructs models of animal tracks and notes differences and similarities in size, shape, and function.	(7) Identifies patterns with objects and manipulates objects to form new and predetermined patterns. (6, 7) Identifies existing symmetry in the arrangement of objects and distinguishes between differences and similarities in patterns.		
(1) Uses models to represent geological features and life forms of a prehistoric period.	(2) Given a set of rocks, discerns a pattern enabling classification of the rocks according to at least three of the following: color, texture, weight, size, layering, and shape.	(5) Describes the physical characteristics of an insect and differentiates among the parts of a mealworm's body.	(7) Conducts single estimates, verifies them, and demonstrates different methods of counting.
(1) Uses symbols and diagrams to represent the various components of a circuit.			(3) Makes basic weather predictions from data obtained from instruments and sources.

6 1 Outdoor Education 2 Oceanography 3 Astronomy: Beyond the Solar System 4 Small Things and Microgardening 5 Geology 6 Chemistry and Kitchen Physics 7 Solar Energy and Conservation	(1) Recognizes that the magnetic field of the earth is responsible for the action of a compass (4) Identifies conditions which influence the growth of molds and those conditions which delay or prevent mold growth	(3) Realizes that the distance between stars and galaxies is increasing, the result being an expanding universe (5) Realizes that plant succession and erosion contribute to geologic change 2a
7 1 Classification 2 Structure of Organisms 3 Activities of Organisms 4 Ecology 5 Heredity and Evolution 6 Treatment of Data	(4) Lists some changes in an ecosystem that may result from man's activities (4) Identifies factors that may cause two environmental changes and designates further ramifications that might result	(5) Cites evidence that living things have changed in complexity through the ages
8 1 Using Data 2 Astronomy 3 Geology 4 Meteorology 5 Oceanography 6 Energy 7 Discovering With Instruments	(2) Applies the relationship of the orbital distance of an object to its space and period (3, 4, 5) Identifies human activities that may alter the environment (3, 4, 5) Applies the geologic processes of vulcanism, weathering, erosion, and drift in explanations of the earth's structure and features (4) Lists and describes factors that would influence air pressure and humidity (6) Identifies variables that affect the rate or amount of energy transfer in a simple system (6) Identifies factors related to the current energy crisis	(2) Describes the apparent motion of the stars at night and through the seasons (3) Outlines the history of the earth's climatic changes throughout geological time (3) Compares life forms common to different periods of geological time
9 Physical Science 1 Radiant Energy 2 Magnetism and Electricity 3 Motion 4 Physical Properties of Matter 5 Chemical Properties of Matter 6 Nuclear Energy 7 Mechanics	(1) Verifies that perception is the interaction of sensory stimuli and mental interpretation (2) Realizes the causes of a short circuit and relates this to the safety features employed in home wiring (3) Applies Newton's Laws of Motion in explanations of motion encountered in everyday experience (6) Realizes the physiological effects of radioactive materials on living organisms	(3) Realizes that motion is the time rate of change of position and characterizes different types of motion (5) Differentiates between chemical and physical changes (6) Explains the transmutation of elements using the three main modes of radioactive decay (7) Indicates how simple machines transform energy, transfer energy, multiply force, multiply speed, or change the direction of a force

	(7) Becomes aware of methods for using the sun as an alternative energy source.	(2) States the general characteristics of sea water and identifies characteristics which distinguish sea water from fresh water. (3) Cites the major characteristics of stars, galaxies, and the universe, e.g., size, color, gas components, moving, and distance. (3) Names and fixes the positions of selected constellations. (6) Recognizes properties of liquids such as surface tension, cohesion, flow, and density. (6) Recalls that the atom is considered to be the smallest unit of an element and that molecules of elements consist of one atom or two or more atoms bonded together.
(4) Explains two fundamental materials cycles. (4) Gives two examples of materials recycling for use by other organisms.	(3) States the energy requirements of a living organism and gives examples of amounts of energy needed and used for different functions.	2-b
(2) Describes the appearance of lunar and solar eclipses and explains how they occur. (2, 4) Explains the reasons for the phases of the moon and for seasonal changes on a planet. (3) Relates how a rock may change from one type to another in the rock cycle. (4, 5) Diagrams the pathways of carbon dioxide, oxygen, and water through the environment. (4, 5) Diagrams the major wind patterns and ocean currents.	(2) Explains the process involved with the fusion reaction of stars. (2) Compares energy forms in terms of advantages and disadvantages of "seeing ability." (3, 5, 6) Discusses fuel sources including fossil fuels, solar power, nuclear power, hydropower, tidal movements, current movements, and use of the thermocline. (4, 5) Applies thermal dynamics in explanations of the wind, water cycle, and ocean currents.	(3) Identifies rock types as igneous, metamorphic, or sedimentary in origin. (5) Explains how salinity, temperature, and pressure affect the density of a liquid.
(1) Identifies cycle as a fundamental concept in explanations of wave phenomena. (2) Relates the cycles per second rating of household current to the operation of a generator.	(1) Identifies visible light as but one manifestation of the energies represented by the electromagnetic spectrum. (2) Explains the ways in which different sources are used to produce electricity. (6) Compares and contrasts fission and fusion processes as energy sources. (All) Defines energy as the ability to do work and realizes energy can be transferred from one form to another.	(4) Realizes mass is a fundamental property of matter and compares masses quantitatively. (4) Compares and contrasts the physical properties of solids, liquids, and gases. (4, 5) Identifies common materials by their physical and chemical properties. (5) Differentiates among elements, compounds, and mixtures.

2-C

	(2) Relates the theories of creation and development of life in the ocean. (3) Relates the current data and theories concerning the origin of the universe. (3) Becomes aware of theories that explain the birth, life, and death of a star and their relationships to such phenomena as black holes and quasars.	
(2, 3) Identifies several interactions within one system of an organism and gives two examples of interactions of different systems. (2, 3) Describes one difference between the system of man and of another organism that fits each to life in a certain environment. (4) Identifies evidence that interactions have occurred or are occurring in an ecosystem. (4) States an operational definition of an ecosystem, given several different examples of ecosystems, and identifies several variables that influence viable natural communities.	(5) Gives an example of a living thing that is the result of changes in the genetic code acting in a changing environment.	(5) Identifies three factors that produce or influence change.
(4) Discusses heat transfer between cold and warm air masses in the atmosphere. (5) Explains how the density differences in sea water result in ocean currents.	(2) Relates a probable sequence for the evolution of a star. (2, 3) Explains the historical evolution of the calendar. (2, 3, 4, 5) Compares and contrasts the historical growth of understanding in the fields of astronomy, meteorology, geology, and oceanography. (3) Charts ancient events on a geological time line. (3) Reviews the changes in the earth's crust according to plate tectonic theory.	(2) Relates gravitational force between two objects to the mass of the objects and the distance between them. (2, 4, 5) Describes the gravitational effect of the moon, sun, and other astronomical bodies on the earth. (3) Compares and contrasts the speed and wave motion of primary and secondary earthquake waves. (4) Explains the effects of Coriolis force on the direction of winds, high and low pressure systems, and water gyres.
(2) Realizes that electrical charges always tend to become neutralized. (5) Realizes that chemical changes are reversible.		(2) Becomes aware of magnetic and electric field effects and the forces between charged objects. (3, 4, 5) Differentiates between mass and weight. (3, 7) Applies characteristics of forces in explanations of changes in motion. (3, 7) Compares forces quantitatively.

(1) Uses a food web to describe the interrelationships of organisms in an ecosystem. (2) Uses maps and models to identify the major topographic features of the ocean floor.	(1) Identifies and classifies plant twigs and buds based upon their characteristics. (1) Records similarities and differences among the assembled skeletons of different animals.	(1) Identifies the major differences and similarities among green and nongreen plants and specifies conditions which influence the growth and development of these plants. (1) Describes the generalized structure of bones. (2) Becomes aware of the variety of animal life in the ocean and designates the major types of organisms that live in sea water. (4) Describes the generalized structure of a cell.	2d-e
	(1, 2, 3) Describes three life functions and three structures that show a relationship between man and another organism. (5) Applies chromosome and gene theory in explaining the continuity of life.	(2) Identifies systems of an organism that are involved with carrying on life processes. (2, 3) Identifies specimens as living or nonliving and justifies choices. (2, 3) Applies cell theory in explanation of the structure and function of living things. (3) Cites basic materials requirements for the maintenance of life. (3) Compares and contrasts metabolic processes in plants and animals. (4) Explains three food-getting relationships in nature.	(4, 5) Plans a desired change and predicts the possible consequences of the change. (4, 5) Relates the interaction of genetic variability and environment to the probable survival of organisms.
(2) Compares the big bang, steady state, and pulsating theories of origin of the universe. (3) Summarizes Alfred Wegener's theory of continental drift. (3) Demonstrates an ability to interpret the relief of land using contour lines.	(1) Detects patterns in given data presented in tables and graphs. (2) Differentiates between the relative luminosities and temperatures of giant, main sequence, and dwarf stars using the Hertzsprung-Russell diagram. (2) Classifies galaxies by shape according to Hubble's classification system. (4) Classifies clouds using the following terms: nimbus, stratus, cumulus, and cirrus. (5) Identifies the basic characteristics of western ocean boundary currents, eastern ocean boundary currents, northern hemisphere currents, and southern hemisphere currents.	(3) Describes three processes involved in the formation of a fossil. (3) Identifies five common fossils of Ohio. (3) Compares and contrasts the growth of a mineral crystal and a living cell. (5) Relates limiting factors of marine organisms including sunlight, pressure, nutrients, and temperature.	(1) Uses detected trends in data to predict by interpolation and extrapolation. (4) Attempts to predict weather conditions using simple meteorological equipment.
(1) Applies the wave model in explanations of the characteristics of sound and electromagnetic radiation. (2) Applies the atomic model in explanations of electrical charge and current. (2) Uses water movement in a plumbing system as an analogy in explanations of current, electromotive force, and resistance. (4) Applies concepts of the kinetic molecular theory in explanations of the properties of solids, liquids, and gases. (5) Becomes familiar with atomic and molecular models used to explain the characteristics of elements and compounds.	(1) Applies geometric rules in analyzing and predicting the behavior of light impinging on mirrors, glass blocks, prisms, and lenses. (2) Identifies the major types of electric circuits and realizes the relationship of current, voltage, and resistance in each. (1, 2, 3) Becomes aware that the inverse square law for light is one manifestation of a pattern of physical phenomena, e.g., Universal Law of Gravitation, Coulomb's Law.	(1) Explains common defects in the human eye and how they can be corrected.	

10, 11, 12 Biology 1 Ecology and the Biosphere 2 Diversity Among Living Things Classification of Protista, Plants, and Animals 3 Within the Organism Anatomy and Physiology 4 Energy and Life Photosynthesis and Respiration 5 Continuity of Life Reproduction, Heredity, and Evolution 6 Patterns in the Biosphere Terrestrial and Marine, Past and Present	(1) Describes both natural and manmade changes in the environment and their effects on the biosphere (3, 4) Realizes that cells respond to changes in the environment in a predictable fashion	(5) Becomes aware of the changes through which an organism attains final form during its embryological development (6) Explains how ecosystems have changed during the history of the earth 3-a
10, 11, 12 Chemistry 1 Fundamental Concepts 2 Classification of Elements 3 Chemical Formulas and Equations 4 Measurement 5 Physical States of Matter 6 Solutions and Their Properties 7 Chemical Reactions 8 Descriptive Chemistry	(1, 5, 6, 7, 8) Recognizes cause and effect as a major basis of science and differentiates between cause and effect in various situations (7) Solves problems dealing with entropy, enthalpy, and free energy changes in chemical reactions (7) Identifies the factors that affect reaction rate	(2) Explains chemical changes in terms of making and/or breaking chemical bonds (5, 7) Compares and contrasts physical and chemical changes
11, 12 Physics 1 Measurement and Data Handling 2 Mechanics, Energy, and Kinetic Theory 3 Waves and Wave Phenomena 4 Electricity and Magnetism 5 Energy, the Environment, and Our Economy	(1, 2) Calculates the theoretical and actual mechanical advantages of machines (1, 2, 3, 4, 5) Realizes that the set of rules for calculating a quantity is found within the definition of the quantity (3) Produces diffraction in a physical situation with different types of waves such as sound, light, or water (4) Relates force on a current-carrying conductor to the magnetic flux density, the current in the conductor, and the length of wire in the magnetic field (4) Relates the concept of induction to the factors that affect induction and to the operation of transformers, motors, and generators	(5) Realizes that the fundamental tenet of the constancy of the speed of light in Einsteinian relativity results in changes of mass, length, and time when observed from moving frames of reference

(1, 4) Realizes that matter cycles in and energy flows through the environment by means of the photosynthesis-respiration *processes* (3, 6) Analyzes the mechanical, social, and living systems to compare the types of feedback which control each system	(1) Diagrams the flow of energy through a food chain and an energy pyramid, showing that energy is not recycled but lost as *heat from the biosphere* (3, 4) Explains how various organisms obtain and transfer energy in order to perform their life function (3, 4) Realizes that enzymes permit chemical change to take place at reduced temperatures compatible with life	(1) Diagrams and explains various matter cycles reinforcing the Law of Conservation of Matter (3) Uses cell theory in explanations of how matter is organized in living things (4) Realizes that the interdependence of living things and their environment is related to the transformation of matter chemically from one form to another 3-6
	(2) Recognizes that all chemical changes either release or absorb energy (7) Defines entropy and enthalpy and explains their relationship to exothermic and endothermic reactions	(3) Solves problems based on mass relationships in chemical reactions (8) Lists the elements and compounds most important to our society and specifies which of their properties make them so useful
(2) Compares qualitatively and quantitatively the periods and frequences of different periodic motions (4) Compares and contrasts alternating current circuits with direct current circuits	(2) Cites the First and Second Law of Thermodynamics and demonstrates the ability to apply those laws in explanations of everyday situations (2, 5) Uses equations defining the forms of energy in situational problems	(5) Realizes that $E = mc^2$ expreses the energy equivalent to a given amount of mass

(1) Explains homeostasis and cites examples of its functioning in the biosphere (3) Identifies and explains the basic structure and function of internal systems involved in maintaining equilibrium in plants, animals, and protists	(5) Applies the principles of population genetics in explaining the evolution of adaptations of groups of organisms. (5, 6) Describes relationships among organisms and their ancestors that are used as support for the theory of evolution	3-c
(6) Lists factors that affect solution equilibrium and predicts how each factor will alter the equilibrium (7) Explains the relationship of LeChatelier's Principle and chemical equilibrium	(1) Analyzes early developments in science and indicates how they evolved into the present-day branches of science (1) Describes the fundamental entities of the physical universe (matter, energy, space) and discusses how these have changed as the universe evolves	(2) Contrasts ionic and covalent bonding. (5) Distinguishes among the types of weak bonds and attractive forces that hold molecules and/or ions together. (6) Describes the solvation mechanism in terms of forces between particles
(2) Indicates that an object is in equilibrium if the resultant of all vector forces acting on the object is zero	(3) Traces the development of the laser and, using the basic principles of laser operation, indicates possible future applications	(2) Resolves all concurrent forces acting on an object into one force acting at a specific point. (2) Applies Newton's Second Law in explaining the nature and magnitude of acceleration. (2) Resolves motion into its three-dimensional vector components. (2) Realizes the relationship between impulse and momentum and applies the conservation concept in an isolated system. (4) Applies Coulomb's Law in analyses of forces between charged particles.

(5) Uses a model to represent a specific DNA base sequence	(2) Lists basic characteristics of life that are common to all living things (2) Categorizes organisms into the proper classification levels according to their general anatomical features (2) Realizes the purposes of a biological classification system (5) Identifies the patterns of reproduction found in living things and cites specific examples	(3) Locates and identifies the various important anatomical structures of plants, animals, and protists (3) Realizes that a multicellular organism is composed of many types of interdependent cells (6) Compares and contrasts external and internal structures characteristic of organisms living in various habitats	(5) Diagrams punnet squares and uses algebraic equations to express frequency distributions involved in heredity 3-d, e
(2) Describes the current model of an atom and traces its origin from ancient times (5) Describes the three normal states of matter in terms of the kinetic theory	(2) Discusses the basis of Mendeleev's classification of the elements and the reasoning that led him to it (2) Subdivides "matter" by several different schemes (i.e., homogeneous, heterogeneous or elements, compounds, mixtures) (3) Writes and balances equations representing four different classifications of reactions (4) Defines measurement and describes its importance in both daily life and scientific activity (6) Lists the differences and similarities in the Arrhenius, Bronte-Lowry, and Lewis acid-base theories (7) Detects equilibrium by recognizing constancy of macroscopic properties	(8) Explains how chemistry is related to ecology	
(2) Uses the kinetic theory of matter to compare the concepts of temperature and heat (2, 3, 4) Applies the principles and concepts of waves to specific areas such as sound, electromagnetic energy, heat (3) Compares and contrasts the characteristics and properties of longitudinal and transverse waves (3) Uses the photoelectric effect in explanations indicating that light has not only the characteristics of waves, but also the characteristics of particles	(1, 2) Compares qualitatively and quantitatively the periods and frequencies of different periodic motions and produces different periodic motions with objects of different materials (3) Represents the physical situation produced (e.g., ray diagrams, equations) when a source of light is reflected, passed through a lens or prism or some combination of the above (4) Applies the rules that have been established to explain the distribution of charges in a region (4) Calculates total capacitance in either series or parallel combinations (4) Identifies circuits as series, parallel, or combination and determines current, electromotive force, and resistance values in specific situations	(5) Becomes aware of the exponential growth of the human population and the resultant energy demands	(1) Evaluates data based upon the quality of experimentation and probabilistic nature of that data (1, 2) Realizes that temperature is a statistical property of an object or region that indicates the ability of heat energy to be transferred from one region to another. (1, 5) Gains insight into the complex interaction among energy, ecology, and economics through cost-risk benefit analysis.

K-12

INSTRUCTIONS FOR ASSEMBLING PROCESS SCOPE AND SEQUENCE CHART

1. Overlap pages so that all vertical and horizontal lines match continuously according to the pattern below.

2. Trim page edges as necessary.

1-a	1-b	1-c	1-d
2-a	2-b	2-c	2-d

	OBSERVING Observing involves using one or more of the senses in a personal experience of environmental perception. This skill is employed in every phase of daily living. When direct observation is inadequate or impossible, indirect methods are used. Observations may be influenced by the background and previous experiences of the observer.	**CLASSIFYING** 1a A systematic procedure used by a person to impose order on a collection of objects or events.
LEVEL: UNIT **K** 1. Pattern Blocks 2. Mirror Cards 3. Changes 4. Zoo Animals 5. Light and Shadows 6. Attribute Games and Problems 7. Eggs and Tadpoles 8. Geo Blocks	(2) Uses mirrors and mirror cards to make observations on the size and shape of reflected images. (4) Identifies the physical characteristics of zoo animals through direct observation and visual material. (5) Observes physical characteristics of various materials and living things and notes that the observations change through time. (7) Observes structural characteristics during the development of frogs.	(2) Classifies patterns of reflected images on the basis of shape. (3) Identifies the properties of a set of pattern blocks and groups these on the basis of observed likenesses and differences. (5) Groups changes on the basis of their similarities and differences (rapid and slow, decaying and nondecaying, rusting, evaporating). (6) Uses attribute blocks to demonstrate different methods of classification.
1 1. Clay Boats 2. The Solar System 3. Energy and Magnetism 4. Animals and Brine Shrimp 5. Primary Balancing 6. Tangrams 7. Mobiles 8. Spinning Tables and Machines	(1) Identifies and describes those clay shapes that float best in water. (1-8) Makes observations from different positions or locations. (3) Notes the interaction of a magnet with various types of materials. (4) Recognizes that a microscope is an extension of the sense of sight. (8) After observing the motions of a variety of objects on a spinning table, uses chalk and crayons to investigate the observations.	(2) Groups planets on the basis of their similarities and differences.
2 1. Green Plants: Growing Seeds 2. Geology: Rocks and Minerals 3. Air, Weather, and Seasons 4. Butterflies and Moths 5. Exploration of Outer Space 6. Match and Measure 7. Energy and Static Electricity 8. Geo Blocks	(1, 2, 4) Moves the object being observed for a different perspective. (1, 4) Notes physical characteristics and changes during the growth and development of plants, moths, and butterflies. (3) Recognizes that instruments such as a thermometer and barometer are extensions of one's senses.	(2) Groups rocks and minerals into subsets based on a single characteristic such as hardness or luster.
3 1. The Earth's Features 2. Energy and Conservation: Electricity 3. Astronomy: Solar System and Galaxies 4. Simple Machines and Structures 5. Animals and Animal Tracks 6. Drops, Streams, and Containers 7. Mirror Cards	(2, 3, 6, 7) Differentiates actual observation from personal interpretation.	(5) Groups and regroups animal tracks into subsets according to the characteristic under consideration. (6) Groups and regroups drops of various substances according to the characteristics under consideration.
4 1. Prehistoric Life 2. Geology: Rocks and Minerals 3. Mystery Powders and Solutions 4. Energy: Magnetism and Sound 5. Insects and the Behavior of Mealworms 6. Conservation and Stream Tables 7. Peas and Particles	(3, 5) Observes repeatedly to accumulate sufficient evidence upon which to base an inference.	(2, 3) Organizes data into a series of subsets that can be used as a key to identify one component of the series.

MEASURING Measuring involves developing a comparison or quantitative description of such properties as length, area, volume, weight, temperature, or pressure. Both standard and nonstandard units are used in the development of the skill.	**COMMUNICATING** Any one of several procedures involving various media and which carries information from one person to another.	**INFERRING** Reaching a conclusion on the basis of observation and/or past experiences.
	(7) Relates changes in the development of tadpoles and frogs both verbally and pictorially.	
(1) Discovers the weight that a clay boat will hold before it sinks. (5) Orders concrete objects by weight and becomes familiar with such terms as fulcrum and balance. (5) Compares the size and relative weight of various objects. (6) Fits objects to matching forms using tangram pieces to make a given pattern; designs and draws an original tangram. (7) Compares shapes and weight during the construction of a balanced mobile.	(2) Collects data relating to the solar system and describes this data either verbally or pictorially. (4) Relates changes in the development of brine shrimp both verbally and pictorially.	(4) Recognizes that observation is the basis for inference and, after observing, infers what unidentified brine shrimp eggs might be.
(6) Compares objects to a nonstandard unit of measure such as a length of string or a block. (6) Compares quality of objects (e.g., length, weight, volume, area) in terms of more than and less than. (8) Given a set of blocks, builds different structures of equal volume.	(1) Maintains a growing plant and records pictorially or in writing information pertinent to the topic. (4) Gives a verbal description of moths and butterflies such that another person can distinguish between the two.	(7) After making observations concerning sound and static electricity, makes inferences about everyday experiences with these two forms of energy.
(4) Uses standard units of measure in English and metric systems in the design, construction, and evaluation of various simple structures. (4) Identifies objects or structures as one-dimensional, two-dimensional, or three-dimensional. (4) Measures force using a spring scale.	(5) Records data pertinent to a study of animals by making plaster molds and prints of their tracks. (6) Records data and describes the conditions that may have influenced the observations of the characteristics of liquids.	(5) Given track records of animals that depict changes in the animal's activity, states inferences about events that might have led to the change (e.g., predator chasing prey). (5) Recognizes that two people may make different inferences from the same observation. (5) Given track castings, prints, or mystery track cards, infers the characteristics of the animal that made the track.
(7) Makes simple estimates of quantity and verifies them; demonstrates different methods of counting (sampling such as halving, doubling, volume counting, area counting).	(2) Given an assortment of rocks, describes their physical properties and their interaction with other materials used in the standard identification process. (2, 3) Constructs charts and/or graphs to represent data collected in activities about the characteristics of rocks and mystery powders. (3) Given mystery powders and various liquids, describes their mixing behaviors and physical properties. (5) Given a mealworm placed in a container, records events in sequence and describes verbally and pictorially conditions necessary for growth, anatomical characteristics, movements, and the life cycle of the mealworm.	(4) After manipulating such materials as magnets, compasses, and tuning forks, separates observations that support inferences from those that do not.

PREDICTING	**QUESTIONING**	**HYPOTHESIZING** 1c
Predicting what future observations will be on the basis of previous information, which distinguishes it from "guessing."	To raise an uncertainty, doubt, or unsettled issue that may be based on the perception of a discrepancy between what is observed and what is known by the questioner.	Stating a tentative generalization that may be used to explain a relatively large number of events but which is subject to immediate or eventual testing by one or more experiments.
(1) Predicts the effect of light on the images of two- and three-dimensional objects.	(1-8) Develops questions concerning his/her observations.	
	(1-8) Develops questions concerning his/her observations. (7) Recognizes the differences between questions and problems.	(1, 3, 4, 8) Selects observations that assist in answering questions.
	(1-8) Develops questions concerning his/her observations. (8) Recognizes the differences between questions and problems.	(1, 2, 4, 7) Selects observations that assist in answering questions.
(2) From data recorded during the investigation of the components of a simple circuit, predicts ways that the bulb can be made to light. (3) Records observations of the phases of the moon and uses recorded data to make phase predictions.	(4) Recognizes the differences between questions and problems.	
(2, 3) On the basis of recorded data and generalizations, predicts the identity of powders making up an unknown compound and the identity of unknown rocks. (3) From prior observations, predicts the behavior of drops of food coloring when placed in liquids of different densities. Uses additional observations to confirm or modify predictions.	(1, 3, 6) Constructs questions that can be answered through the accumulation and interpretation of data.	(1, 3) Distinguishes among opinion, fact, and hypothesis. (5) Given descriptions of experiments with mealworms (or with other animals), identifies alternative conclusions that explain the data.

EXPERIMENTING Planning a series of data gathering that will provide a basis for testing a hypothesis or answering a question.	**PROCESSING AND INTERPRETING DATA** To find a pattern or other meaning inherent in a collection of data. Leads to stating a generalization.	**FORMULATING MODELS** 1d Constructing models involves the building of a mental, physical, or verbal representation of an idea, object, or event as a basis for explanation and interpretation. Models may be used to communicate information, demonstrate the interrelatedness of subjects, or express abstract ideas.
(3, 5, 7) Performs simple short-term activities to answer some questions.		(2) Recognizes that certain familiar objects (pictures, spheres, etc.) are models of real objects (earth, planet, sun).
(1, 2, 8) Manipulates equipment and performs simple short-term activities to answer some questions and/or solve a problem. (2) Conducts simple experiments and records pertinent observations.	(2) Records and selects data useful in categorizing rocks and minerals into the three major groups.	(5) Uses pictures and models to explain various means of space travel and expresses ideas about the benefits of such actions.
(2) Conducts simple experiments and records pertinent observations in an investigation of different numbers of components and different arrangements in a simple electric circuit. (2) Performs a simple experiment to distinguish conductors from nonconductors. (4) Conducts simple experiments and records pertinent observations in an investigation of how machines make work easier and more efficient.		(1) Interprets models and pictures of the earth's features and infers conditions that may have influenced these features. (3) Develops three-dimensional models as he/she explores the characteristics of planets, stars, and other celestial bodies.
(1, 3, 6) Identifies constants and variables in an experiment.	(1, 3, 6) Distinguishes between data obtained by direct observation and ideas obtained by interpretations of the data. (2, 3) Uses collected data to make an inference or prediction.	

5 1. Electricity: Batteries and Bulbs 2. The Individual and the Environment 3. Weather and Seasons 4. Light and Optics 5. Gases and Air 6. Water Flow 7. Aviation and Aerodynamics	(1, 2, 5, 7) Recognizes cause and effect relationships after observing related events. (2, 3, 5) Uses standard measures for carefully defined observations. (3) Observes factors relating to weather and seasons as evidence upon which to base inferences and predictions.	(2, 3) Classifies data from a series of observations to indicate frequency. (2, 3, 5) Organizes data into predetermined categories.
6 1. Outdoor Education 2. Oceanography 3. Astronomy: Beyond the Solar System 4. Small Things and Microgardening 5. Geology 6. Chemistry and Kitchen Physics 7. Solar Energy and Conservation	(1, 4) Recognizes cause and effect relationships after observing related events.	(1, 5) Uses the characteristics of a classification system to identify individual members of the system.
7 1. Classification 2. Structure of Organisms 3. Activities of Organisms 4. Ecology 5. Heredity and Evolution 6. Treatment of Data	(3, 4, 6) Recognizes cause and effect relationships after observing related events.	(1) Constructs a classification scheme on the basis of personally derived criteria. (1, 2, 5) Uses the characteristics of a classification system to identify individual members of the system.
8 1. Using Data 2. Astronomy 3. Geology 4. Meteorology 5. Oceanography 6. Energy 7. Discovering With Instruments	(1, 4, 5) Recognizes cause and effect relationships after observing related events.	(1, 2, 3, 5) Selects and uses classification schemes appropriate to the data being organized and its intended use.
9-12 In grades 9-12, the processes acquired in grades K-8 are reinforced and refined as they are applied in the learning situations in each discipline.		

(2, 3, 7) Estimates measures of distance, area, volume, weight, time, temperature, and speed. (5) Uses formulas to generalize methods of measuring (e.g., V = l x h x w).	(3) Constructs graphs to present weather data recorded over an extended period of time. (7) Constructs graphs to represent data on aircraft distance and time aloft.	(5, 7) Separates observations that support inferences from those that do not.
(1) Uses various techniques such as triangulation or water displacement to measure length, area, or volume when a tool may not be applied in direct measurement. (4) Uses approximate measures properly.	(2, 3, 7) Uses various types of media to obtain and transmit information. (5) Records observations according to a system developed for a specific problem under study.	(4) While investigating the relationship of environmental factors and mold growth, makes additional observations that can be used to test an inference. (5) During the identification procedures for rocks and minerals, separates observations that support inferences from those that do not.
(3, 4, 5, 6) Uses tools of measurement appropriately. (6) Differentiates among concepts that are one-dimensional, two-dimensional, and three-dimensional.	(1-7) Records and presents observations according to a system designed for a specific problem under study.	(4, 5) Recognizes limitations of inferences. (4, 6) States several possible inferences from a group of related observations.
(1, 2, 3) Differentiates among concepts that are one-dimensional, two-dimensional, and three-dimensional. (1-7) Uses tools to make precise measurements. (2, 3, 4) Correctly applies the concept of scale in making dimensional interpretations from a model. (2, 3, 5) Uses various indirect techniques to measure a factor when a tool may not be directly applied (e.g., volume by displacement of water, distance by triangulation).	(1-7) Uses communication skills to facilitate group processes. (3, 4, 5, 6) Communicates inferences or predictions with the supporting data.	(3, 4, 5, 6) Realizes that inferences may need changed on the basis of additional observations.

2c

(3) Uses data from graphs to make a prediction.	(4) Constructs questions related to reflection, refraction, shadows, and color that can be answered by making observations and collecting data. (6) Constructs questions related to the properties of liquids.	(2) Distinguishes among opinion, fact, and hypothesis.
(1) Uses quantitative measurements to make predictions more accurate.	(7) Constructs questions related to solar energy and the conservation of natural resources that can be answered by the accumulation and interpretation of data.	(1, 4) Constructs hypotheses that can be evaluated by observation or inference.
(3, 4, 6) Uses quantitative measurements to make predictions more accurate.	(1-6) Constructs questions that can be answered by inference from accumulated data.	(2-6) Applies the procedures for testing the validity of a hypothesis.
(1, 4, 5, 6) Suggests the outcome of future observations based on inferences that were found valid. (1-7) Uses interpolation and extrapolation to make predictions from trends in data.	(1-7) States questions in such a way that they can be answered experimentally.	(1-6) Modifies hypotheses on the basis of controlled experiments. (2-6) Realizes the relationships among hypothesis, theory, and law.

2d

(1) Designs and conducts controlled experiments to analyze the effects of changing various circuit components. (5) Makes observations and collects data about air and its interaction with other materials. Analysis of this data leads to the conclusion that air is matter. (7) Participates in a project involving the design, construction, and testing of aircraft made of paper and similar materials, making observations and analyzing data to arrive at a conclusion.	(3, 5, 7) Uses collected data to make an inference or prediction.	(3) Uses two or more models to explain related events.
(4) Designs and conducts controlled experiments to test hypotheses concerning the relationship of environmental factors to mold growth. (6) Plans and conducts controlled experiments to analyze the properties of liquids.	(5) Communicates inferences about geologic forces with the supporting data.	(3) While using models to explain ideas such as light year, origin of the universe, etc., identifies limitations of models. (7) Uses measurements to construct models to scale of houses and other structures to illustrate the proper use and conservation of energy.
(3, 4, 6) Designs and conducts controlled experiments to answer a given question or test a hypothesis.	(3, 4, 6) Organizes obtained data by constructing graphs and tables. (4, 5, 6) Determines the relevancy of previously obtained data in new situations.	(3, 4, 6) Uses measurements to construct models to scale.
(1-7) Designs and conducts a series of controlled experiments to evaluate the effect of more than one independent variable.	(1, 4, 6) Uses mean, median, and range in processing data. (1-7) Identifies patterns in data organized in table and graphs. (1-7) Makes valid generalizations from a body of data.	(2-6) Adapts or modifies a model to aid in the solution of a given problem.

EVALUATION OF STUDENT PERFORMANCE

The following section on evaluation is the product of a committee endeavor of Upper Arlington teachers, psychologists, administrators, a parent, a student, and a Board of Education member. Evaluation is viewed as the procedures related to the acquiring and the processing of information needed to improve teaching and student learning. The following general observations regarding the evaluation procedures of student performance are applicable to all subject areas. Specific evaluation samples and/or suggested evaluation procedures for the science program are supplied in each instructional unit.

I. What Information Is Needed and Why?

Data about student performance is needed to:

A. Plan for instruction in keeping with individual student needs (i.e. for grouping students, for selecting materials, and for identifying methods most likely to enhance student learning and progress).

For this purpose we must assess:

-- the location of students on the various learning continua,

-- the commonality and variations in learning styles and learning rates among students,

-- the commonality and variations in interests and motivational factors among students, and

-- the special needs of individual students.

B. Assess student progress by securing measures of the extent to which instructional objectives have been achieved before and after instruction.

C. Evaluate program impact as a basis for review and renewal of curriculum guides and educational planning.

For this purpose we must know:

-- the extent to which the student body is meeting broad, curricular objectives, and is making progress in keeping with community expectations; and

-- the effects on student progress of regular and innovative programs.

CLASSIFICATION OF EVALUATION PROCEDURES

Adapted from: Gronlund, Norman E.
Measurement and Evaluation in Teaching.
New York: MacMillan Publishing Co., 1976.

Type of Evaluation	Type of Information	Examples	Examples of Occasion[1]
Maximum performance	Determine what a student can do when performing at his/her best	Aptitude tests Individual testing under optimal conditions	Evaluation by specialist, performance under high motivation conditions
Typical performance	Determine what a student will do under natural conditions	Observational techniques Daily quizzes Worksheets	Daily work
Criterion-referenced	Describe pupil performance in terms of a specified domain of instructionally relevant tasks (e.g., can add single-digit whole numbers)	Teacher-made mastery tests Custom-made tests from test publishers Observational techniques	By classroom teacher for readiness and mastery checks, pre- and post-testing, instructional planning

---

[1] Added by evaluation committee

CLASSIFICATION OF EVALUATION PROCEDURES (Cont.)

Type of Evaluation	Type of Information	Examples	Examples of Occasion[1]
Diagnostic	Determine causes (intellectual, physical, emotional, environmental) of persistent learning difficulties	Published diagnostic tests Informal diagnostic tests Observational techniques Miscue analysis	On referral basis by counselors, TIES, psychologists, special education teachers and tutors, speech therapists, nurses, and others
Summative	Determine end-of-course achievement for assigning grades or certifying mastery of objectives	Teacher-made survey tests Performance rating scales Product scales Final exams	By teachers and for administrative purposes

---

[1] Added by evaluation committee

II. How Can the Information Be Obtained?

The selection of specific techniques will be influenced by the instructional, reporting, and administrative purposes to be served. Consideration should be given to selecting information-collecting techniques and instruments that are broad enough in scope to provide data that can be used for a variety of purposes. Procedures and techniques must measure consistently what is intended. Because of the margin of error inherent in subjective and objective evaluation techniques, more than one type of instrument or method should be used for obtaining desired information. Teacher judgment regarding the student's work and the scores on objective tests serve as checks on one another and bring to light errors and inconsistencies that call for further investigation.

A. The following are some possible examples of subjective evaluation:

- observation of student behavior under various situations;
- rating of written and oral reports, projects, and task or job performance
- grading of essay-type tests;
- student self-evaluations, attitude surveys, interest inventories;
- individual conferences with students; and
- parental feedback and employer reports.

B. The following are some possible examples of objective evaluation techniques:

- standardized, multiple choice, and short answer tests; and
- time sampling and other formalized observation techniques.

C. The following is a classification of evaluation procedures according to purpose:

CLASSIFICATION OF EVALUATION PROCEDURES (Cont.)

Type of Evaluation	Type of Information	Examples	Examples of Occasion[1]
Norm-referenced	Describe pupil performance in terms of the relative position held in some known group (e.g., ranks tenth in a classroom group of thirty)	Standardized aptitude tests Standardized achievement tests Teacher-made survey tests Interest inventories Adjustment inventories	District-wide by classroom teachers for placement and program impact
Placement	Determine possession of prerequisite skills, degree of mastery of course objectives, and/or best mode of learning	Survey type tests Readiness tests Aptitude tests Pretests on course objectives Self-report inventories Observational techniques	Administratively by counselors, TIES for placement decisions, by teachers at beginning of course or school year to plan instruction
Formative	Determine learning progress, provide feedback for reinforcement of learning, and identify and correct learning errors	Teacher-made mastery tests Custom-made tests from test publishers Observational techniques Criterion referenced tests Weekly quizzes	During course or school year at completion of instruction units, for progress reports, for student self-evaluation, to evaluate effectiveness of specific instructional materials and methods

---

[1] Added by evaluation committee

III. How Should the Information Be Recorded and Reported?

The uses the information is to serve and the limitations of time and resources will govern recording and reporting procedures. The information should be succinct, readily understood, and stated in terms that reduce to a minimum the possibilities of misuse and misinterpretation. Board policies and regulations[1] are followed regarding the nature and form in which information is recorded in the student's cumulative file, and regarding the grading and reporting procedures for communicating evaluative information to parents and students.

Other considerations in developing recording and reporting procedures are:

-- information for administrative and research purposes should lend itself to statistical analysis;

-- a uniform information management system should be adopted when more than one person will provide or use the information being collected, for example, when records of skill mastery are transmitted from one grade or school to the next; and

-- the availability of computer capability for storage, retrieval, compilation, and analysis of information will require certain types of record keeping methods.

---

[1] IH, IHA-R, IHAA-R, IHAB, IHAB-R, IHABA-R, IHABAA-R, JR, JR-R

Unit Outline
Kindergarten
Unit: Pattern Blocks

Description of Unit: By constructing patterns from the colorful blocks, children are introduced to a variety of mathematical shapes and sizes. Using a single mirror, they are able to duplicate their patterns and are introduced to the concept of symmetry.

I. Identify Properties of Pattern Blocks

- A. Color
- B. Shape
- C. Size

II. Relating Pattern Blocks to Math Concepts

- A. Count all of the pattern blocks in a pattern
- B. Count the pattern blocks of a certain color
- C. Count the pattern blocks that are a certain shape

III. Pattern Blocks and Structures

- A. Buildings
- B. Pictures
- C. Creative designs

IV. Pattern Block Puzzles

- A. Recreate a puzzle or design
- B. Construct designs with pattern blocks and mirrors

OBJECTIVE:	To develop manipulative and reasoning skills by reconstructing a given small design into a larger size through the use of pattern blocks
TITLE:	"Can You Make It Bigger?"
SOURCE:	Pattern Blocks. ESS Teacher's Guide.
OBJECTIVE:	To develop skills in discriminating by noting the obvious and subtle differences between the pattern blocks
TITLE:	"How Are the Pattern Blocks Different?"
SOURCE:	Pattern Blocks. ESS Teacher's Guide.
OBJECTIVE:	To develop skills in creativity by using pattern blocks and mirrors to create unusual and beautiful designs
TITLE:	"Make Me a Rainbow"
SOURCE:	Pattern Blocks. ESS Teacher's Guide.

Text Materials

Let's Pattern Block It. Activity Resources Co., Inc., 1973.

Pattern Blocks. ESS Teacher's Guide. McGraw-Hill, 1976.

Picture Patterns. William Stokes, 1973.

Kits

Pattern Blocks. ESS Materials Kit.

Exemplary Activity
Kindergarten
Unit: Pattern Blocks

OBJECTIVE: To develop skills relating to mathematical concepts and creativity

MATERIALS AND EQUIPMENT: ESS materials kit for Pattern Blocks

PROCEDURE:

Pattern blocks may be used independently by children, or children may be teacher-directed through questions and activities such as the following:

1. Have children make pictures and things. Ask questions like: Can you make animals? Can you make people? Can you make a bridge? a train? a fence? a plane?
2. Can you make any one of the things you made, but make it bigger? smaller?
3. Try some roads. Use your mirrors. Can you make the roads wider? narrower?
4. Can you make a floor with just hexagons? with triangles? with diamonds?
5. Make squares from squares, small up to big.
6. Make one shape out of other shapes.
7. Trace around your design, for others to fill in with blocks.

Evaluation Sample
Kindergarten
Unit: Pattern Blocks

As with most manipulative activities at the kindergarten level, student evaluation of Pattern Blocks is based largely upon teacher observation of the following:

A. Student's ability to construct and create designs and shapes
B. Student's ability to verbalize his/her understanding of unit concepts
C. Student's ability to solve problems

Unit Outline
Kindergarten
Unit: Mirror Cards

Description of Unit: Mirror Cards is a series of individual or group activities that give children opportunities to experiment with concepts relating to optics, patterns, and symmetry. The materials kit provided with the unit includes mirrors and a wide variety of pattern cards.

I. Observation Skills

  A. View a picture or a pattern on a Mirror Card
  B. Attempt to replicate that pattern with a mirror

II. Classification Skills

  A. Sort cards based upon observable characteristics
  B. Decide which cards can be replicated
  C. Which cards cannot be replicated

III. Measurement and Symmetry

  A. Compare the size of patterns
  B. Compare the shape of patterns
  C. Compare the arrangement of patterns relative to the line of symmetry

IV. Prediction of Patterns

  A. Patterns that can be made with a mirror
  B. Patterns that cannot be made with a mirror

V. Symmetry

  A. Line of symmetry
  B. One-half of an object -- fractions

VI. Congruent Figures and Patterns

VII. Reflection -- Light and Its Properties

VIII. Translation and Rotation

IX. Informal Geometry

  A. Angles
  B. Distances
  C. Orientation

Suggested Activities
Kindergarten
Unit: Mirror Cards

OBJECTIVE: To build something with blocks (Pattern Blocks). Place a mirror on one side. Use blocks to construct the image you see in the mirror.

TITLE: "Building With Blocks and Mirrors"

SOURCE: ESS Teacher's Guide, Mirror Cards

OBJECTIVE: To encourage students to notice objects in the classroom or outdoors that exhibit symmetry

TITLE: "Symmetry Hunt"

SOURCE: ESS Teacher's Guide, Mirror Cards

OBJECTIVE: To enable students to make their own symmetrical pictures and then test them with mirrors

TITLE: "Symmetrical Crafts"

SOURCE: ESS Teacher's Guide, Mirror Cards

Text Materials

Light and Shadows. ESS Teacher's Guide. McGraw-Hill, 1976.

Mirror Cards. ESS Teacher's Guide. McGraw-Hill, 1976.

My Magic Mirror Book. Scholastic Books, 1978.

Picture Patterns. William Stokes, 1973.

Kits

Mirror Cards. ESS materials kit

Pattern Blocks. ESS materials kit

OBJECTIVE: To develop skills in paper folding and cutting

MATERIALS AND EQUIPMENT: Paper, scissors, potatoes, paint, materials kit for Mirror Cards

PROCEDURE:

Fold a piece of paper. Cut out any pattern through both layers. The cut-out spaces that you see when you unfold the paper will be congruent. Children enjoy making such patterns. They may want to experiment with folding a sheet of paper two, three, or even four times. This activity may be correlated with cutting snowflakes or valentine hearts to discover symmetry.

OBJECTIVE: To become familiar with various geometric shapes

MATERIALS AND EQUIPMENT: A firm potato, knife, paint, and paper

PROCEDURE:

Take a firm potato. Cut off a slice, making a nice flat cross section. You can either use this surface as a design or now cut out a design. Cover the surface of the design with paint, and print on any kind of paper. You will obtain congruent copies of the design, although as you turn the paper or the potato, the design will be in different positions.

Mirrors could also be used in studying leaves or other symmetrical objects.

Evaluation Sample
Kindergarten
Unit: Mirror Cards

The McGraw-Hill Evaluation Program for ESS is available from Webster Division, McGraw-Hill Book Company.

Because Mirror Cards are designed for informal use in the classroom, a formal evaluation tool is not recommended. Teacher observation with the use of developmental questions would be more appropriate in evaluating students' insights while using Mirror Cards. One effective way to provide the physical atmosphere necessary for informal interaction with the material is to set aside a Mirror Card table where students can explore and manipulate the materials. The teacher can place a check list with the Mirror Cards so that students can record those sets that they have completed to their satisfaction.

The teacher should take care that students do not feel limited to making the "right" picture. Students should be encouraged to explore the many possible pictures that can be made while using the mirror and a card. There are obvious answers and other possible interpretations. The ESS manual for Mirror Cards suggests some developmental questions that can be used for evaluation.

Once students have the cards and the rules have been explained, the teacher will not need to do much supervising. Students should be allowed to proceed at their own rate. They should feel free to work alone or in groups. When students make mistakes, allow them to find their own solutions by trial and error. Students should feel free to return to any set as often as they wish.

It is best not to ask students to formulate rules about what they are doing with the cards. Students often understand more concepts than they are able to verbalize.

Unit Outline
Kindergarten
Unit: Changes

Description of Unit: Children are provided with opportunities to see, distinguish, and gain understanding about the natural changes that are caused by the growth of living organisms such as bacteria, as well as changes that are caused by nonliving organisms such as rusting and melting.

I. Setting up Changes Jars

   A. Things that will never change
   B. Things that may or may not change

II. Different Kinds of Changes

   A. Melting and freezing
   B. Drying out
   C. Crystalizing and dissolving
   D. Rusting
   E. Sprouting
   F. Rotting

III. Things That Effect Change

   A. Wetness or moisture
   B. Light and dark
   C. Temperature
   D. People

Suggested Activities
Kindergarten
Unit: Changes

OBJECTIVE: To acquaint children with things that rust and things that do not rust

TITLE: "Rusting"

SOURCE: Changes, ESS Teacher's Guide

OBJECTIVE: To acquaint children with crystals, where they come from, how they occur, and whether they can be made to grow

TITLE: "Crystalizing and Dissolving"

SOURCE: Changes, ESS Teacher's Guide

OBJECTIVE: To determine what "rotting things" have in common, how changes caused by living things differ from those caused by nonliving things, and what causes materials to decay

TITLE: "Rotting"

SOURCE: Changes, ESS Teacher's Guide

OBJECTIVE: To enable the child to distinguish between a solid and a liquid, and to understand what is meant by melting

TITLE: "The Conservation of Mass"

SOURCE: Changes, ESS Teacher's Guide

Text Materials

Changes. ESS Teacher's Guide. McGraw-Hill, 1976.

Gateways to Science. McGraw-Hill, 1979.

How a Seed Grows. Thomas Crowell Company, 1960.

My Plant. Addison-Wesley, 1976.

Filmstrips

Things in the World That Change. Available from school libraries.

Your Changing World. Available from school libraries.

Exemplary Activity
Kindergarten
Unit: Changes

OBJECTIVE: To enable the children to distinguish between a solid and a liquid, and to understand what is meant by melting

MATERIALS AND EQUIPMENT: Snow, box, measuring stick, pad of paper, pencil

PROCEDURE:

The teacher should help the children bring snow into the room first thing in the morning. Children then measure the snow and record. Later in the day when the snow has melted, the water should be measured and recorded.

Questions to Ask

1. How much snow was in the box?
2. What happened to the snow?
3. How much water is in the box?
4. What made the snow melt?

Children will enjoy writing their own books about this experiment. They can also be involved in picture and chart making in order to express themselves in regard to this laboratory activity.

Evaluation Sample
Kindergarten
Unit: Changes

The unit can be best evaluated through teacher observation of children as they perform the various activities. Class discussion of the activities and concepts will also demonstrate a child's understanding of the different kinds of changes that have been emphasized.

Unit Outline
Kindergarten
Unit: Zoo Animals

I. Variety Within the Animal Kingdom

- A. Sizes of animals
- B. Types or species of animals
- C. Colors of animals
- D. Some animals lay eggs
- E. Some animals bear their young alive
- F. Animals make sounds that can help identify them

II. Variety in the Way Animals Move

- A. Bend
- B. Swim
- C. Fly
- D. Burrow in ground
- E. Crawl
- F. Walk

III. Variety in the Way Animals Eat and What They Eat

- A. Kinds of food
- B. Sources of food
- C. Amount of food needed

IV. Variety of Places in Which Animals Live

- A. In water
- B. On land
- C. In the air
- D. In trees
- E. Underground

Suggested Activities
Kindergarten
Unit: Zoo Animals

OBJECTIVE: To show methods for keeping a variety of animals in the classroom, using the experience to web together language, math, social studies and science

TITLE: "Animals in the Classroom"

SOURCE: Animals in the Classroom, ESS Teacher's Guide

OBJECTIVE: To give children experience in creating stories. Children will dictate short stories about zoo animals to the teacher or mother helpers. The stories are typed, duplicated, and put together in a folder to be given to the children and their parents.

TITLE: "Making a Book of Zoo Animals"

SOURCE: Teacher developed

OBJECTIVE: To give children a closeup view of zoo animals in their own classroom. Contact Sue Schear at the Education Department of the Columbus Zoo (889-8335) to arrange for animals to be brought to your classroom.

TITLE: "A Visit From the Columbus Zoo"

SOURCE: Teacher developed

OBJECTIVE: To make children aware of the large variety of animals and plants that can be found in our city

TITLE: "Wildlife in Our Community"

SOURCE: Teacher developed activity to be conducted at the Upper Arlington Schools' Land Laboratory

Resources
Kindergarten
Unit: Zoo Animals

Text Materials

Animals in the Classroom. ESS Teacher's Guide. McGraw-Hill, 1972.

Concepts in Science, Book 1. Harcourt, Brace and Jovanovich, 1972.

A First Look at Snakes, Lizards, and Other Reptiles. Scholastic Book Services, 1975.

Giraffes at Home. Thomas Crowell Co., 1972.

Films -- Grandview Heights Public Library

Jazzoo, 18 min.

Morning Zoo, 10 min.

Zoo Animals in Rhyme, 11 min.

Filmstrips

Various filmstrips available from school libraries

Materials

An excellent egg incubator is available from the science room in each elementary building.

Exemplary Activity
Kindergarten
Unit: Zoo Animals

OBJECTIVE: To give children experience in creating stories, pictures, and models that relate to the unit on zoo animals

MATERIALS AND EQUIPMENT: Art materials such as clay, construction paper, scissors, milk cartons, easel, and paint

PROCEDURE:

A. Children use various art materials to create a large model of a zoo and animals on a table top or in a sand table. The children can use clay to construct models of the various animals. Models of trees, cages, and so forth can be constructed from milk cartons and construction paper.

B. Children use an easel and paint to draw pictures of different zoo animals. The children can then create stories or share information with the class that relates to the animals they have drawn.

C. The children can use the building materials from other science units, such as Geo Blocks, Pattern Blocks, Attribute Games and Problems, and Mirror Cards to construct models of the zoo and various zoo animals.

Evaluation Sample
Kindergarten
Unit: Zoo Animals

The unit on Zoo Animals is usually culminated by a Board paid field trip to the Columbus Zoo. The following evaluation tools can be used after the field trip or at other times during the unit:

1. Children draw pictures and create stories relating to the zoo trip and zoo animals.

2. The teacher shows pictures of zoo animals to the children to see if they can remember the names of the animals and other pertinent information.

3. Group discussions and individual conferences can be used to determine a child's understanding of animals, their needs, their differences, and so forth.

Unit Outline
Kindergarten
Unit: Light and Shadows

Description of Unit: In their exploration of light and shadows, children find new meanings in a number of ordinary objects and phenomena. They use many shapes and their own movements to examine light sources and the shadows they cast. An opportunity is given for young children to experiment with spatial relationships in simple ways.

I. Shadows
   A. Manipulation
   B. Identification

II. Practical Use of Shadows
   A. Size
   B. Interrelationships

III. Image Formation -- Pinhole Camera

IV. Shadows Caused by Angle of Sun
   A. Change during one day
   B. Change in another season

Suggested Activities
Kindergarten
Unit: Light and Shadows

OBJECTIVE: To predict the projected image of various two-dimensional cut-out figures and of three-dimensional objects when shown on an overhead projector

TITLE: "What Will Its Shadow Be?"

SOURCE: Teacher developed from Light and Shadows, ESS Teacher's Guide

OBJECTIVE: To have the student and teacher do a pencil sketch of another student's profile to be cut into a silhouette

TITLE: "Is That Really My Profile?"

SOURCE: Adapted from Light and Shadows, ESS Teacher's Guide

OBJECTIVE: To practice manipulating cut-out figures on the overhead projector as visuals while telling a story

TITLE: "Telling Folk Tales With Shadow Figures"

SOURCE: Light and Shadows, ESS Teacher's Guide

OBJECTIVE: To follow the shadow cast by the sun throughout the day through an "X" taped on a sunny window

TITLE: "X Marks the Spot"

SOURCE: Light and Shadows, ESS Teacher's Guide

Text Materials

Gateways to Science. McGraw-Hill, 1979.

Light and Shadows. ESS Teacher's Guide. McGraw-Hill, 1976.

What Makes a Shadow? Scholastic Book Services, 1962.

Films -- Grandview Heights Public Library

A Light Beam Named Ray, 20 min., 1973.

Exemplary Activity
Kindergarten
Unit: Light and Shadows

OBJECTIVE: To tell a folktale to the class, illustrating part or all of it with shadow figures on the overhead projector

MATERIALS AND EQUIPMENT: Folktales, overhead projector, paper, pencils, scissors

PROCEDURE:

Read several folktales to the class and then let them choose one to tell to the other students (alone or with one other student). Figures for visuals may be traced from the book, if desired. (Translucent onionskin typing paper may be used for tracing as well as projecting, because light does not show through it.)

After a few visuals are cut out, experiment with them on the overhead projector to be sure they are of a size to work well together. Cardboard may be added for support to the bottom of visuals to avoid hands showing on projected image. A cut-out layer of "grass" across the end of the projector nearest the screen will "ground" the objects to avoid the appearance that they are floating in space.

Cut out all visuals. Practice manipulating the objects while telling the story. Tell the story with the visuals to the classroom audience. If the story contains words too difficult for the student to read, or if the student is a nonreader, perhaps they could tell the story in their own words. Also, the teacher could read the story while the student provides the visual activity on the overhead projector.

Evaluation Sample
Kindergarten
Unit: Light and Shadows

Evaluation is based on teacher observation of the child's performance with the light and shadow activities. Group discussion and sharing time can also be a valuable means of evaluating the child's understanding of the unit.

Unit Outline
Kindergarten
Unit: Attribute Games and
Problems

Description of Unit: The unit provides activities for children by using a set of hardwood blocks of many shapes and sizes. The materials kit also includes such things as creature cards and people pieces to assist children in developing skills relating to manipulating, classifying, and predicting.

I. Sorting Subsets

   A. According to one attribute or several attributes
   B. Joining sets

II. Describing

   A. People pieces
   B. Creature cards
   C. Attributes and values of a set

III. Manipulating

   A. Reforming patterns
   B. Matching models
   C. Constructing abstracts

IV. Diagramming

   A. Mapping a model
   B. Building

V. Conceptualizing

   A. Mathematical relationships
   B. Predicting patterns
   C. Constructing abstracts

OBJECTIVE: To sort A blocks into sets having one common attribute

TITLE: "Sorting A Blocks"

SOURCE: Attribute Games and Problems, ESS Teacher's Guide

OBJECTIVE: To classify creature cards according to attributes

TITLE: "Creature Cards"

SOURCE: Attribute Games and Problems, ESS Teacher's Guide

OBJECTIVE: To classify People Pieces according to attribute

TITLE: "People Pieces"

SOURCE: Attribute Games and Problems, ESS Teacher's Guide

Text Materials

Attribute Games and Problems. ESS Laboratory Cards. McGraw-Hill, 1976.

Attribute Games and Problems. ESS Teacher's Guide. McGraw-Hill, 1976.

Kits

Attribute Games and Problems. ESS Materials Kit and Activity Cards.

Exemplary Activity
Kindergarten
Unit: Attribute Games and
Problems

OBJECTIVE: To describe differences between various objects

MATERIALS AND EQUIPMENT: Property Blocks from ESS materials kit

PROCEDURE:

I. Teacher holds up the picture of a shape and the child must find a property block that differs from the picture in only one property.

   A. Teacher holds up a picture of a fat yellow circle.

      Child could pick:

      fat green circle
      or
      fat yellow square
      or
      thin yellow circle

   B. Teacher continues to hold up pictures and the children learn to discriminate among the many blocks.

Evaluation Sample
Kindergarten
Unit: Attribute Games and
Problems

In addition to teacher observation and individual or group discussion, the kit materials include some small attribute stickers that can be used as self-checking tools.

Unit Outline
Kindergarten
Unit: Eggs and Tadpoles

Description of Unit: Children will observe the transformation of frog eggs into tadpoles and then into frogs. Through the process skills of observing, experimenting, and questioning at each stage of development, students gain direct experience with the life cycle of an animal.

I. Observation

- A. Describe the physical characteristics of frog eggs
- B. Describe changes in frog eggs
- C. Describe functions of the various structures of the tadpole as it changes
- D. Determine the likenesses and differences of frog eggs and tadpoles
- E. Record in pictures the observed sequential order of developmental stages

II. Measurement

- A. Compare developmental sizes of tadpoles during their transition
- B. Measure quantities of food

III. Inference and Prediction

- A. Predict the number of frogs that could result from one batch of eggs
- B. Predict the development and refinement of tadpole structures
- C. Predict the internal changes in developing frogs
- D. Infer and predict where frog eggs and tadpoles can be found

OBJECTIVE: To establish proof that a tadpole uses gills to breathe during early stages of life

TITLE: "Use of Gills by Tadpoles"

SOURCE: Eggs and Tadpoles, ESS Teacher's Guide

OBJECTIVE: To make children aware that there is an organizational development of frogs that follows a strict pattern

TITLE: "Sequence of Frog Development"

SOURCE: Teacher developed

OBJECTIVE: To make children aware that not all eggs will develop

TITLE: "Hatching Rate of Frog Eggs"

SOURCE: Eggs and Tadpoles, ESS Teacher's Guide

Text Materials

Eggs and Tadpoles. ESS Teacher's Guide. McGraw-Hill, 1976.

Hawes/Madden. Why Frogs Are Wet. New York: Crowell Co., 1962. Available from school libraries.

Hogner, Dorothy. Frogs and Polliwogs. New York: Crowell Co., 1956. Available from school libraries.

McClung, Robert. Peeper, First Voice of Spring. New York: Wm. Morrow Co., 1977. Available from school libraries.

Morris, Loverne. Frogs as Wild Pets. Chicago: Children's Press, 1973. Available from school libraries.

Films -- Grandview Heights Public Library

Amphibians: Frogs, Toads, and Salamanders

Kits

Eggs and Tadpoles. ESS Materials Kit.

A coupon for redeeming live frog eggs is available from the science consultant. The frog eggs will be delivered to your school.

Exemplary Activity
Kindergarten
Unit: Eggs and Tadpoles

OBJECTIVE: To establish proof that tadpoles use gills to breathe during early stages of life

MATERIALS AND EQUIPMENT: Food coloring, eye dropper, magnifying glass

PROCEDURE:

Have children place drop of food coloring in front of tadpole. They can then observe the colored water coming from the tadpole's gills at its sides.

Evaluation Sample
Kindergarten
Unit: Eggs and Tadpoles

At the kindergarten level, observation and oral questioning are the major tools of evaluation. Having children draw pictures of their observations is helpful. For appropriate questions, see Eggs and Tadpoles, ESS Teacher's Guide, Part II: Suggestions for Teaching, page 10.

Unit Outline
Kindergarten
Unit: Geo Blocks

Description of Unit: Geo Blocks consist of 330 unpainted hardwood blocks in a variety of sizes and shapes. The large number of blocks makes possible a wide range of sorting and classifying activities that help develop logical thinking and a basic understanding of the concept of numbers. The blocks are ideal for exploring geometric shapes and developing mathematical concepts such as surface area and weight.

I. Introduction of Materials

    A. Large box of Geo Blocks
    B. Problem cards

II. Buildings, Blocks, and Structures

    A. Towers
    B. Cities
    C. Creative Structures

III. Two-Dimensional Blocks

    A. Flat shapes
    B. Slopes
    C. Grouping
    D. Outsides and insides

Suggested Activities
Kindergarten
Unit: Geo Blocks

OBJECTIVE: To develop skills in symmetry by building a large tower

TITLE: "Constructing a Tall Building"

SOURCE: Geo Blocks, ESS Teacher's Guide

OBJECTIVE: To use hands-on manipulative objects to explain the concepts of length and width

TITLE: "Two-Dimensional Blocks"

SOURCE: Geo Blocks, ESS Teacher's Guide

OBJECTIVE: To enable children to become adept at grouping blocks according to very subtle similarities

TITLE: "All Things Can Be Separated Into Groups"

SOURCE: Geo Blocks, ESS Teacher's Guide

Text Materials

Attribute Games and Problems. ESS Teacher's Guide. McGraw-Hill, 1976.

Geo Blocks. ESS Teacher's Guide. McGraw-Hill, 1974.

Pattern Blocks. ESS Teacher's Guide. McGraw-Hill, 1974.

Kits

Geo Blocks. ESS Materials Kit.

Exemplary Activity
Kindergarten
Unit: Geo Blocks

OBJECTIVE: To develop skills in "grouping" according to differences and similarities

MATERIALS AND EQUIPMENT: Wooden blocks from Geo Blocks kit

PROCEDURE:

The activity is an ongoing process and can be done as a whole class activity or on an individual basis with students.

1. Select any 3 blocks to make a group. How are they all the same? How are they different? What other blocks can fit in this group?

2. Are there some blocks that are the same in every way? in one way? in two ways? in no way?

3. Put all of your blocks together that have at least one triangle on them. You now have two groups -- those with a triangle face and those with no triangle faces. Can you divide each of these groups into smaller groups?

Evaluation Sample
Kindergarten
Unit: Geo Blocks

An activity such as Geo Blocks can best be evaluated in an informal manner through such means as:

1. Teacher observation of student performance
2. A child's ability to construct an answer to a question or problem posed by the teacher
3. A child's demonstration of creativity with the Geo Blocks

Unit Outline
Grade 1
Unit: Clay Boats

Description of Unit: The ESS unit Clay Boats allows students to perform experiments independently relating to the properties of water and to objects that float or sink. Children design boats out of materials such as clay, aluminum foil, and waxed paper and test the construction of their designs through the use of different cargo weights. Clay Boats can be used as a whole-class activity or independently used by small groups and individual students.

I. Properties of Water

  A. Floating and sinking
  B. Surface tension

II. Buoyancy of Various Objects and the Construction of Boats

  A. Clay
  B. Aluminum foil
  C. Waxed paper

III. Shapes and Sizes That Relate to Floating Objects

  A. Round
  B. Square
  C. Oval

IV. Different Types of Cargo and Their Effect on Boats

  A. Paper clips
  B. Marbles
  C. Metal washers

V. Skills of Communication Relating to Boats That Are Constructed

  A. Observations
  B. Predictions
  C. Conclusions
  D. Recording information

Suggested Activities
Grade 1
Unit: Clay Boats

OBJECTIVE: To construct a floating container from clay; to identify and describe the clay shape that floats best in a container of water

TITLE: "Will It Float?"

SOURCE: Clay Boats. ESS Teacher's Guide, pp. 8-15.

OBJECTIVE: To share results and ideas on construction of boats to hold the most cargo; to formulate reasons why one boat can support a greater cargo than another one; to devise, construct, and estimate cargo weights boats will hold before sinking

TITLE: "How Much Cargo?"

SOURCE: Clay Boats. ESS Teacher's Guide, pp. 16, 17, 22, 23.

OBJECTIVE: To estimate the amount of cargo that a floating container can support in water and to predict whether an object will float, tip over, or sink; to keep written records of predictions of estimated cargo and actual capacities

TITLE: "Pre-formed Containers"

SOURCE: Clay Boats. ESS Teacher's Guide, pp. 18-21.

Text Materials

Clay Boats. ESS Teacher's Guide.

Clay Boats. Unit Objective Outline.

Floating and Sinking. Thomas Crowell, 1967.

Gateways to Science. McGraw-Hill, 1979.

Sink or Float. ESS Teacher's Guide.

Films -- Grandview Heights Public Library

Buoyancy, 14 min.

Kits and Materials

ESS materials kit for Clay Boats

Activity cards for Clay Boats

Exemplary Activity
Grade 1
Unit: Clay Boats

OBJECTIVE: To devise, construct, and estimate the amount of cargo a clay boat will hold before sinking

MATERIALS AND EQUIPMENT: Small containers with WARM water; 1 oz. balls of oil-based modeling clay; trays or paper towels to place under water containers; uniform weights (e.g., paper clips, marbles, pebbles, pennies, washers, etc.); sponges and mop (for spills); teacher-made evaluation sheet

PROCEDURE:

Make a boat from your clay that will float. Record on your paper how many paper clips you think your boat will hold; now record the actual number. Try it again. Did your boat hold the same number of paper clips the second time? Change the shape of your boat. Will it hold the same number of clips?

Repeat activity using marbles and record the information.

Group discussion at end of activity:

Record answers to Evaluation Sample #5 and #6 if not already completed.

Discuss:
1. What effect did water have on the boat when it got into the boat?
2. Did the boats always hold the same number of paper clips or marbles? Why?
3. Make a list of characteristics of good boat design (see ESS teacher's guide for Clay Boats, p. 17).
4. How could we get each person's boat to hold the same amount of cargo? (Lead in to using same type containers as boats.)

Evaluation Sample
Grade 1
Unit: Clay Boats

Name ________________________________

1. Draw the shape of a clay boat that would not float.

2. Draw the shape of a clay boat that floats.

3. Guess how many paper clips your clay boat will hold and still float._____

   Actual number _____

4. Guess how many marbles your clay boat will hold and still float. ____

   Actual number _____

5. Does it make a difference whether you drop the item in your boat or you put it in gently? yes no Which way will make the boat hold more?

   ____

6. Which did your boat hold more of -- paper clips or marbles? ________

   Why? ____

7. Aluminum foil boat -- draw the shape of the foil boat that floats.

   Guess how many paper clips your foil boat will hold and still float.

   ______ Actual number ______

8. Plastic cups -- guess how many marbles your cup will hold and still float. _____ Actual number _____

   Guess how many paper clips your cup will hold and still float. _____

   Actual number _____

   Why are the actual numbers of marbles and paper clips the plastic cup will hold before sinking nearly always the same number? (The numbers your clay boats would hold were different.)

   ____

9. Which activity did you like doing the best as we have worked with boats and their cargoes?

Unit Outline
Grade 1
Unit: The Solar System

I. The Sun

  A. A common star similar to other stars in the sky
  B. Size and shape
  C. Its light and heat
  D. Its nine planets

II. The Solar System

  A. The sun, nine planets, and their moons
  B. The names of the nine planets and their order from the sun
  C. Characteristics of the planets
    1. The largest planet -- Jupiter
    2. The smallest planet -- Mercury
    3. The planets with rings around them -- Saturn, Jupiter, and Uranus
    4. The red planet -- Mars

III. The Planet Earth

  A. Size, shape, and properties
  B. The moon
  C. The earth's movement -- rotation and revolution
    1. Day and night -- a year
    2. Causes of the seasons

Suggested Activities
Grade 1
Unit: The Solar System

OBJECTIVE: To enable students to understand better the size, shape, and features of the planets by drawing pictures of them on clear plastic and using an overhead projector for viewing

TITLE: "Let's Draw the Planets"

SOURCE: Teacher developed

OBJECTIVE: To make students aware of the basic concepts that relate to the solar system by keeping booklets that contain brief sentences and accompanying pictures

TITLE: "Solar System Booklets"

SOURCE: Teacher compiled

OBJECTIVE: To give students a visual perception of day and night, years, and seasons

TITLE: "Using Models of Our Solar System"

SOURCE: Science room model; teacher demonstration

Resources
Grade 1
Unit: The Solar System

Text Materials

A Book of Planets for You. Scholastic Book Services, 1974.

Concepts in Science. Harcourt, Brace, Jovanovich, 1972.

Gateways to Science. McGraw-Hill, 1979.

Science, Understanding Your Environment. Silver Burdett, 1978.

Where Is the Moon? ESS Teacher's Guide. McGraw-Hill, 1976.

Films

Solar System, 11 min.

The Universe: Flight to the Stars, 21 min.

Filmstrips

Filmstrips relating to the solar system available from school library and IRC.

Transparencies

The Solar System and The Sun's Family. Milliken transparency books, available in school science room.

Models

Model of Solar System and Rotation/Revolution Model of Sun, Earth, and Moon. Available from science room.

Exemplary Activity
Grade 1
Unit: The Solar System

OBJECTIVE: To provide students with a record of the solar system unit that they can use for reference and also share with their parents

MATERIALS AND EQUIPMENT: Paper, pencil, crayons

PROCEDURE:

Each day the children make a page and accompanying picture for their booklet. When pages are completed, a cover is made and the booklet is stapled together. Upon completion, the class reads over the lessons again and reviews the concepts. Pages are written as part of daily seat work.

Page 1: The earth is round and very large. It rotates around in a circle. While it rotates, it is moving around the sun.

Page 2: The sun is far away from the earth. It is very large, but it looks small because it is far away. The sun is larger than the earth and moon.

Page 3: The sun gives us heat and light, which help us to live. The sun is so hot it gives off light. Sunlight is the brightest light we know. Some of the sun's heat and light reach the earth. Heat and light from the sun are necessary for life on the earth.

Page 4: Our sun is a star. Stars shine all the time. The sun is not shining on us all the time because we are turned away from the sun during our nighttime.

Page 5: Our moon is a satellite. It travels around the earth. Manmade satellites also circle the earth. The moon gets its light from the sun. We only see that part of the moon that is lighted by the sun.

Page 6: Our galaxy is made up of many stars. One of the stars is the sun. There are nine planets moving around the sun.

Evaluation Sample
Grade 1
Unit: The Solar System

Several different methods of evaluation have proven to be successful for this unit:

1. Teacher observation, class discussion, individual sharing of models and other information

2. Each student keeping a journal or notebook containing drawings and comments

3. Testing the students' knowledge of several basic concepts, such as:

   A. Name the nine planets of our solar system in their proper order from the sun. If the students are having problems remembering the planet's names, try this:

      My -- (Mercury)
      Very -- (Venus)
      Educated -- (Earth)
      Mother -- (Mars)
      Just -- (Jupiter)
      Served -- (Saturn)
      Us -- (Uranus)
      Nine -- (Neptune)
      Pizza pies -- (Pluto)

   B. Explain why we have night and day, seasons, and years.

   C. Which members of the solar system move around each other? (The moons move around the planets, the planets move around the sun, the sun moves around the Milky Way Galaxy.)

Unit Outline
Grade 1
Unit: Energy and Magnetism

I. Magnets Have Different Shapes and Sizes

- A. Bar magnet
- B. U-shaped magnet
- C. Round magnet
- D. Square magnet

II. Magnets Will Push or Pull Other Magnets

- A. Magnets have a north pole and a south pole.
    - 1. Unlike poles will attract each other.
    - 2. Like poles will repel each other.

III. A Magnet Will Attract Objects That Are Made of Iron or Steel

IV. A Magnetic Force Can Be Exerted Through Various Materials

- A. Magnetic force will pass through wood.
- B. Magnetic force will pass through paper.

V. A Compass Needle Is a Small Magnet on a Pivot

- A. A compass needle points toward the magnetic north pole.
- B. The earth acts as a giant magnet.

OBJECTIVE: To acquaint the children with at least four types of magnets

TITLE: "Getting to Know Your Magnets"

SOURCE: Room supply of magnets given to all first grade teachers

OBJECTIVE: To help children discover what magnets can do

TITLE: "Using Your Magnets"

SOURCE: Teacher developed. Materials brought from home (cotton, steel screw, rocks, nails, and lots more)

OBJECTIVE: To aid the children in learning about compasses, compass needles, and their uses

TITLE: "The Compass -- What Is It?"

SOURCE: Classroom collection -- materials supplied to all first grade teachers

Text Materials

Magnets and How to Use Them. Scholastic Book Services, 1963.

Mickey's Magnet. Scholastic Book Services, 1956.

The Real Magnet Book. Scholastic Book Services, 1967.

Science, Understanding Your Environment. Silver Burdett, 1978.

Tannenbaum and Stillman. Magnets. Teacher's Manual. McGraw-Hill, 1967.

Films -- Grandview Heights Public Library

Story of Magnetism, 14 min.

Filmstrips

Filmstrips relating to magnetism available from school library and IRC.

Transparencies

Magnetism. Milliken transparency book, available from school science room.

Kits and Materials

Magnastik kit, various magnets, iron filings, activity cards

Exemplary Activity
Grade 1
Unit: Energy and Magnetism

OBJECTIVE: To show that magnetic force can be exerted through various materials

MATERIALS AND EQUIPMENT: 4 oz. plastic cups, wood squares, cardboard and copper squares, newspaper, pairs of bar magnets

PROCEDURE:

1. Put one bar magnet in plastic cup. Try the second magnet to see if it will attract the first one through the plastic cup.

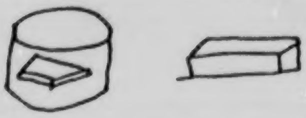
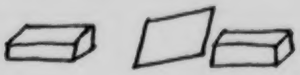
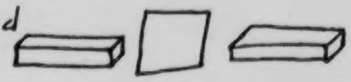
2. Put one bar magnet under the newspaper. See if the second magnet will attract the first one through the newspaper.

3. Make the magnetic force pass through other objects such as a shirt, handkerchief, desk top.

4. Request an ultra-large magnet from science consultant to make magnetic force pass through a hand, a door, and other thick objects.

Evaluation Sample
Grade 1
Unit: Energy and Magnetism

Each child fills in a sheet and then checks with teacher as to results. The evaluation can be done as a group or on an individual basis.

	Yes or No
plastic 	______
wood 	______
cardboard 	______
Add as many as you like.	

Unit Outline
Grade 1
Unit: Animals and Brine Shrimp

Description of Unit: The ESS unit on Brine Shrimp should be integrated into a larger unit of study relating to different types of animals, such as farm animals. By raising brine shrimp, watching their development, and performing simple experiments with them, the students can become acquainted with some of the problems confronted by living organisms. The children will learn many things about brine shrimp, although this is not the main value of the study. They will be amazed to find living things coming from what looks like dirt; their powers of observation and ability to focus on detail will be heightened; and they will have the opportunity to care for their own animals.

I. Different Types of Animals

- A. Farm animals
- B. Zoo animals
- C. Pets in the home
- D. Animals in the wild living in our area
    - 1. Birds
    - 2. Insects
    - 3. Mammals
    - 4. Reptiles and amphibians

II. Characteristics and Needs of Animals

- A. Kinds of food that they eat
- B. Types of homes and shelter that they need
- C. Baby animals in the spring
- D. Taking proper care of our pets

III. The Study of An Animal and Its Life Cycle -- Brine Shrimp

- A. Introducing the "little brown things"
    - 1. Finding out what the eggs are
    - 2. How do we get the eggs to hatch?
    - 3. Food for brine shrimp
    - 4. Watching and recording the growth of brine shrimp
- B. Experiments with brine shrimp
    - 1. Keeping records
    - 2. Making predictions
    - 3. Drawing conclusions

Suggested Activities
Grade 1
Unit: Animals and Brine Shrimp

OBJECTIVE: To become aware that animals require certain types of environment

TITLE: "Will Brine Shrimp Live in Fresh Water?"

SOURCE: Brine Shrimp, ESS Teacher's Guide

OBJECTIVE: To develop skills of observation and rational thinking

TITLE: "How Fast Does a Bring Shrimp Swim?"

SOURCE: Brine Shrimp, ESS Teacher's Guide

OBJECTIVE: To understand the conditions necessary for life and a life cycle

TITLE: "How Do We Get the Brine Shrimp to Hatch?"

SOURCE: Brine Shrimp, ESS Teacher's Guide

OBJECTIVE: To make comparisons between different kinds of animals and the homes in which they live

TITLE: "Animals and Animal Homes"

SOURCE: Teacher developed activity to take place at the Upper Arlington Schools' Land Laboratory

Text Materials

Brine Shrimp. ESS Teacher's Guide. McGraw-Hill, 1976.

Gateways to Science. McGraw-Hill, 1979.

Science, Understanding Your Environment. Silver Burdett, 1978.

The Seed the Squirrel Dropped. Prentice-Hall, 1976.

Whose Eye Am I? Harper and Row, 1968.

Films -- Grandview Heights Public Library

Animal School -- Care of Your Pet, 11 min.

Animals in Spring, 11 min.

Farm Animals in Rhyme, 11 min.

Farms in the Fall, 10 min.

Farms in the Spring, 10 min.

Farms in the Summer, 10 min.

Life in a Drop of Water, 11 min.

Life in the Ocean, 16 min.

Filmstrips

Filmstrips relating to animals and ocean life available from school library or IRC.

Transparencies

Oceanography and Plants and Animals. Milliken transparency books, available from school science room.

Kits and Materials

Brine Shrimp. ESS Materials Kit.

An electric microscope has been placed in each first grade classroom. Microprojector is available from the science room.

Exemplary Activity
Grade 1
Unit: Animals and Brine Shrimp

OBJECTIVE: To understand the environmental conditions that are necessary for the birth and life of an animal -- a brine shrimp

MATERIALS AND EQUIPMENT: Brine shrimp eggs, marine salt, a plastic container for each child, hand lenses, medicine droppers, plastic spoons, measuring cup, water

PROCEDURE:

After the unit has been introduced and discussed, you may now want to explain to the children that the eggs will hatch if they are put in salt water. Because brine shrimp hatch in widely varying concentrations of salt (from one percent to six percent), you will find that some eggs hatch in solutions made from different "recipes." If each child uses about a tablespoon of salt in a cup of water, most of the containers should have live brine shrimp in them within three days.

A. Each child is responsible for replacing water that has evaporated.
B. Observe the tiny brine shrimp with hand lenses and microscopes. Ask the science consultant to bring a microprojector to your room to observe the brine shrimp as they are projected onto a movie screen.
C. Construct a brine shrimp bulletin board and individual journals or notebooks.

Evaluation Sample
Grade 1
Unit: Animals and Brine Shrimp

Evaluation of the Animals and Brine Shrimp unit should take place through the following methods:

1. Teacher observation of children as they are performing the experiments and studies
2. Class discussion relating to the unit
3. Individual journals or notebooks that contain pictures and observations
4. Related materials and information that individual students share with the entire class

Unit Outline
Grade 1
Unit: Primary Balancing

Description of Unit: The children will perform many experiments with familiar materials and simple equipment to help them gain a better understanding of balance and weight. Preliminary experiences with balancing are followed by more specific investigations into the physical laws of balance and the idea of weight and its measurement. This unit is a prerequisite for the unit on Mobiles.

I. The Amount of Weight on Each Side of the Balance Point (Fulcrum) Affects the Balancing

   A. Fulcrum
   B. Weight
   C. Force

II. The Farther an Object Is Moved From the Fulcrum, the Greater Its Force

   A. See-saw
   B. Lever

III. The Volume of an Object Does Not Determine Its Weight

IV. Reshaping an Object or Breaking It Into Pieces Does Not Change Its Weight

V. An Object, No Matter What Its Shape, Acts in a Balanced System as Though All Its Weight Were Concentrated in One Spot

OBJECTIVE: To gain first-hand knowledge using their own bodies; to sense or feel state of suspension or balance, also to see it

TITLE: "Introduction to Balancing"

SOURCE: Teacher developed. Students choose a buddy. Using a bathroom scale, they weigh themselves. Each pair teeter-totters a couple of times only, then attempts balance on "equal-arm" teeter-totter setting. Then they attempt balance on "unequal-arm" teeter-totter setting. This is done on playground with whole class involved in the discussion and observation. If there are at least three teeter-totters together, students do not have to wait very long.

OBJECTIVE: To familiarize self with equipment; to learn ahead of time what difficulties the students might encounter; to identify questions to use for class exploration

TITLE: "Acquaint Yourself With Equipment"

SOURCE: Primary Balancing. ESS Teacher's Guide. Teacher assembles an equal-arm balance (this gives one variable only) using masonite beam. Gather many types of objects to balance. Collect chalkboard erasers, blocks, balls, styrofoam, shoes, books, clay, stones, sticks, popsicle sticks, dominoes, checkers, natural materials, washers, cotton balls, balloons, coins, Cuisenaire rods, and several sheets of cardboard. Teacher predicts outcome before experimenting with various comparisons and/or combinations. Substitute pegboard beam for the masonite beam. Attempt balance using top center hole, middle hole, then bottom center hole. Try many adjustments as you experiment. Also experiment with the four-foot board and the cardboard odd shapes.

OBJECTIVE: To arouse interest and show procedure for assembling additional equipment; to give students framework within which they can operate; to give students words with which they can express their ideas, needs, and findings

TITLE: "Demonstrate Assembling of Equal-Arm Balance"

SOURCE: Primary Balancing. ESS Teacher's Guide. Identify objects and specify safety or housekeeping rules for their use. Set aside an area for these and allow time for all to have access occasionally. Introduce and discuss the terminology for the unit.

OBJECTIVE: To give children experiences and lead toward understanding of concept that when fulcrum is centered, balance is achieved through equal distribution of weight

TITLE: "Equal-Arm Explorations With Masonite"

SOURCE: Primary Balancing. ESS Teacher's Guide

OBJECTIVE: To provide larger-scale operations and tô introduce the second variable of fulcrum's position for balance

TITLE: "Four-Foot Board Explorations"

SOURCE: Primary Balancing. ESS Teacher's Guide

OBJECTIVE: To allow children to use their own body weight, position, and movement for experimentation; also to permit further experimentation with assymetrical arrangements in balancing

TITLE: "Walking Board Explorations"

SOURCE: Primary Balancing. ESS Teacher's Guide

OBJECTIVE: To provide more advanced experimentation where several variables are involved; pegboard allows experimentation with varying degrees of stability in the arrangement, also varying degrees of symmetry/ asymmetry

TITLE: "Explorations Using Table-Model Balance With Movable Pegboard Balance Beam"

SOURCE: Primary Balancing. ESS Teacher's Guide

OBJECTIVE: To help children discover that reshaping an object or breaking it into pieces does not change its weight

TITLE: "Explorations Using Clay"

SOURCE: Primary Balancing. ESS Teacher's Guide

OBJECTIVE: To reinforce feeling that weight does not depend upon shape or volume alone

TITLE: "Weight Surprises"

SOURCE: Primary Balancing. ESS Teacher's Guide

Resources
Grade 1
Unit: Primary Balancing

Text Materials

The Arithmetic Teacher, Vol. 24, No. 1. January 1977, pp. 14-16.

The Balance Book: A Guide for Primary Balancing. ESS Teacher's Guide. McGraw-Hill, 1974.

Gateways to Science. McGraw-Hill, 1979.

Mobiles. ESS Teacher's Guide. McGraw-Hill, 1974.

Kits

ESS materials kit and activity cards for Primary Balancing

Exemplary Activity
Grade 1
Unit: Primary Balancing

OBJECTIVE: To help children discover that reshaping an object or breaking it apart does not change its weight (This is an especially enjoyable activity for children.)

MATERIALS AND EQUIPMENT: From ESS materials kit -- table-model balance set, clay (premeasured into two one-half cup or one-cup balls)

PROCEDURE:

There are two clay lessons involved with this activity. This is an expansion of the clay lesson ideas described in the ESS teacher's guide. Consider providing Clay Lesson 1 for one week; then follow up with Clay Lesson 2 for one week. Two students should work at this station together and they will need about twenty minutes. If teachers can see the student's ideas upon completion, they can ask a few questions and evaluate the work.

Prepare and display the following sheet of directions. Chart paper or similar scale should be used.

Clay Lesson 1

Here are two balls of clay.

1. Choose a friend to work with you. One ball of clay is for you and one is for your friend.

2. Choose one kind of thing for each of you to make alone.

3. Make your object.

4. Now see if your object and your friend's object balance.

5. If they do not, what can you do to make them balance?

6. Tell about what you did here. Make a drawing.

7. Be sure to clean up this work table before you go.

Have fun!

Note: Have the clay balls in measuring cups so the children can divide the clay and put two equal amounts into the two cups.

Clay Lesson 2

Here are two balls of clay.

1. Choose a friend to work with you. One ball of clay is for you and one is for your friend.
2. Do the two balls of clay balance?
3. Use all of your ball of clay to make a boy or a girl or an animal.
4. Your friend is to make one, too.
5. Now see if your object and your friend's object balance.
6. Did you use all your clay to make your object? Be sure you do.
7. Now use that same clay to make something new. Be sure to use all your clay. Your friend will make something new, too.
8. Do the new objects balance?
9. Tell about what you did here. Make a drawing.
10. Be sure to clean up this work table before you go.

Have fun!

Evaluation Sample
Grade 1
Unit: Primary Balancing

A 3-5 minute teacher's discussion with individuals as they finish at the balancing station is advisable when possible. Here is a printed quiz that most of the children can complete. It can be reproduced with a ditto master. The questions should require the top half of the sheet and the bottom is blank for the child's drawing.

Name ____ Date ____________________

1. What kind of objects did you use?

2. How many of each?

3. Did they balance?

4. Was your balance point (fulcrum) in the center?

5. Make a drawing here. Try to show where you placed each object.

Unit Outline
Grade 1
Unit: Tangrams

Description of Unit: The ESS unit Tangrams is a study of science and mathematics that can be used continuously throughout the school year. Each child is given a 7-piece tangram puzzle and asked to put basic shapes together to form new shapes. The problems and patterns that are posed will vary greatly in difficulty, but all will give students hands-on and basic experiences with proportion, area, and the relationship among geometric forms.

I. Explore Relationship Among Various Shapes

  A. Introduce the 7-piece Tangram puzzle
  B. Identify similarities and differences in shape and size of Tangram pieces

II. Develop Dexterity By Manipulating Tangram Shapes

  A. Construct geometric shapes and patterns
  B. Fit the Tangram pieces into a given pattern

III. Develop Original Patterns with Tangram Pieces

  A. Share original patterns with other members of class
  B. Identify similarities and differences in the patterns

Suggested Activities
Grade 1
Unit: Tangrams

OBJECTIVE: To identify and name the various shapes and sizes of Tangram pieces

TITLE: "Shapes and Sizes"

SOURCE: Tangrams. ESS Teacher's Guide

OBJECTIVE: To fit Tangram pieces into a given pattern

TITLE: "Can You Do It?"

SOURCE: Tangrams. ESS Teacher's Guide

OBJECTIVE: To encourage students to develop an original pattern not found on the Tangram cards

TITLE: "New Patterns"

SOURCE: Teacher developed from suggestions in ESS teacher's guide, Tangrams

Text Materials

Gateways to Science. McGraw-Hill, 1979.

Tangrams. ESS Teacher's Guide. McGraw-Hill, 1976.

Kits and Materials

ESS materials kit for *Tangrams*

Activity cards for *Tangrams*

Exemplary Activity
Grade 1
Unit: Tangrams

OBJECTIVE: Given an outline, to try to fit Tangram pieces into the pattern

MATERIALS AND EQUIPMENT: Tangram puzzle pieces and set of Tangram cards for each student

PROCEDURE:

Pass out sets of Tangram puzzle pieces and Tangram cards.

Start with easy cards first and gradually work toward those that are more difficult. Some youngsters give up quickly and others work until the solution is reached. First graders enjoy puzzles and are anxious to share their successes with one another. There is often competition among students over "pattern" solving.

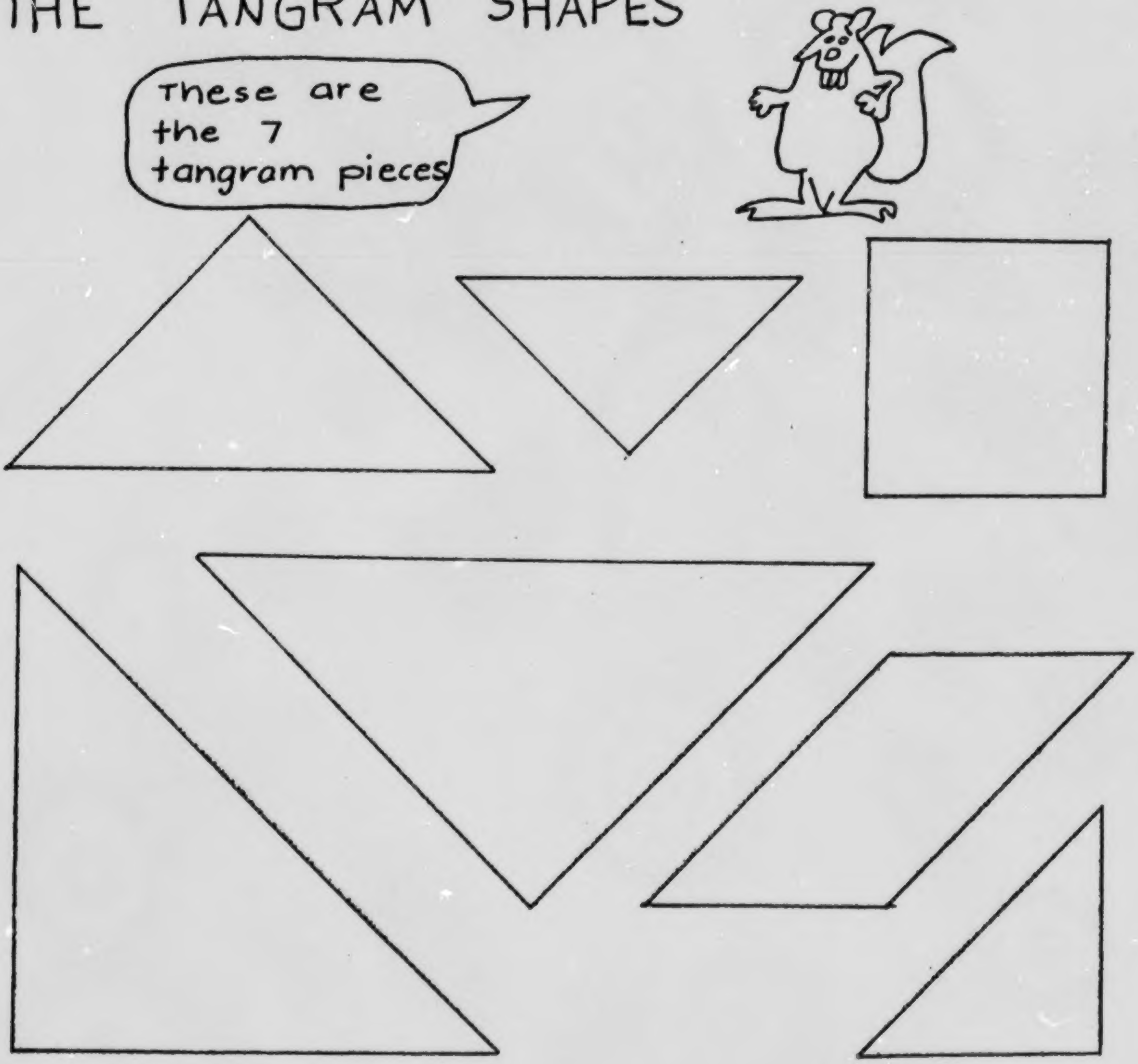
For further activities, see the ESS teacher's guide on Tangrams.

Evaluation Sample
Grade 1
Unit: Tangrams

The teacher should observe the successes and failures of individual students and evaluate accordingly. Students can also maintain a notebook of original Tangram patterns they have created plus other comments that relate to the unit.

Teacher-made activity sheets, similar to the following pages, may also be used as an evaluation tool.

THE TANGRAM SHAPES

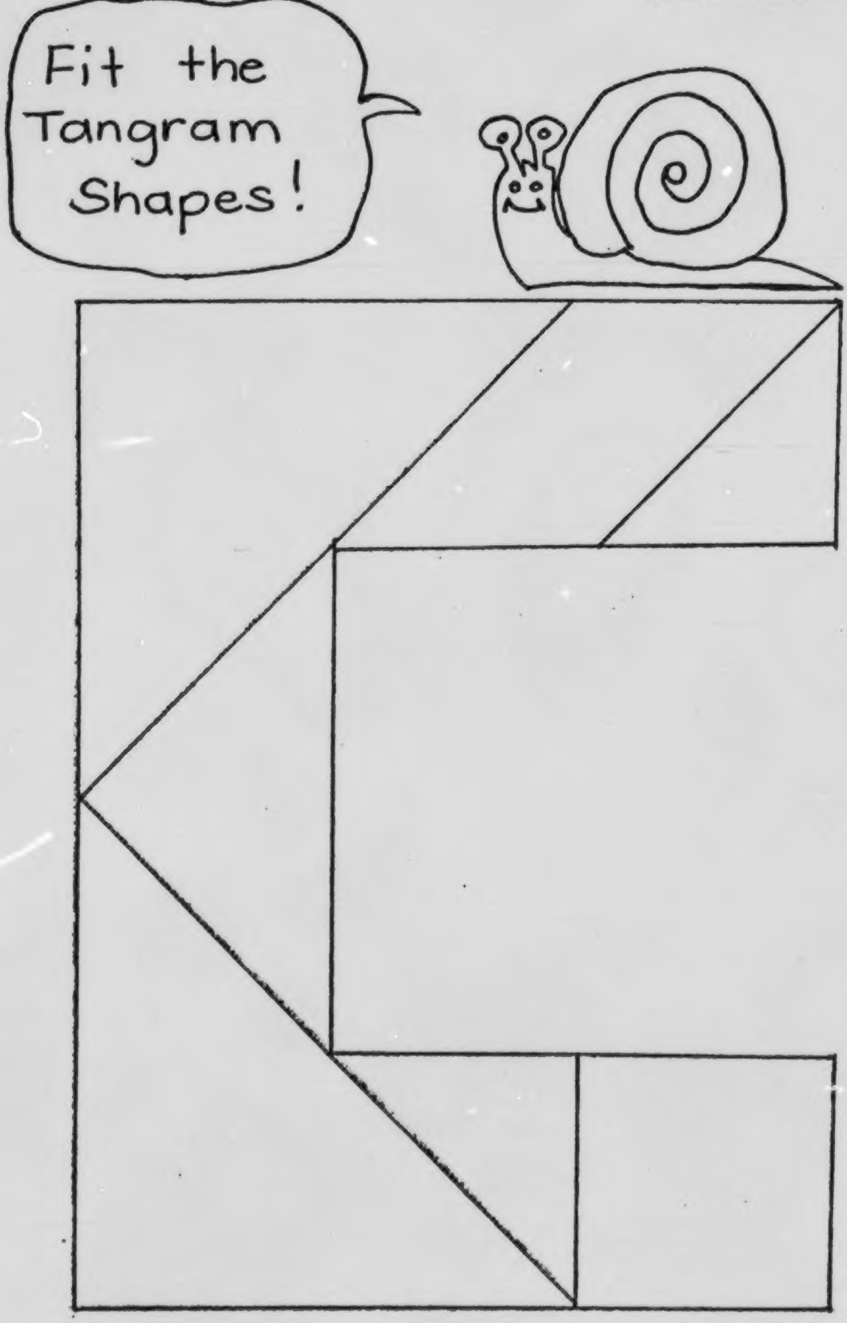

These are the 7 tangram pieces

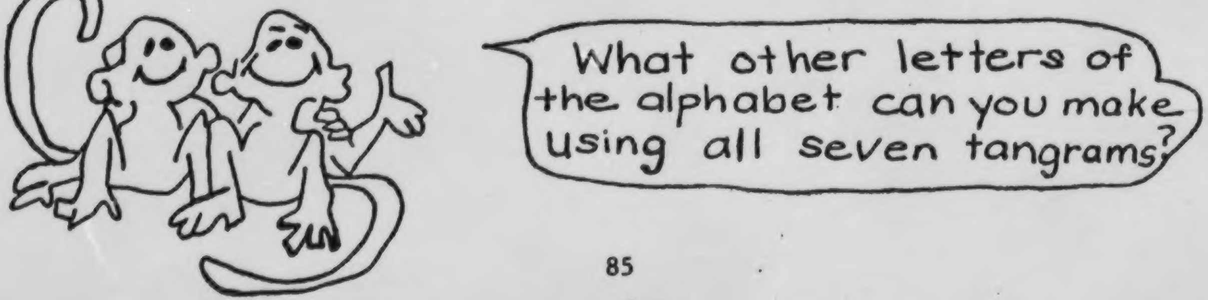
Place your tangram pieces on the shapes above.

How many triangles? ____

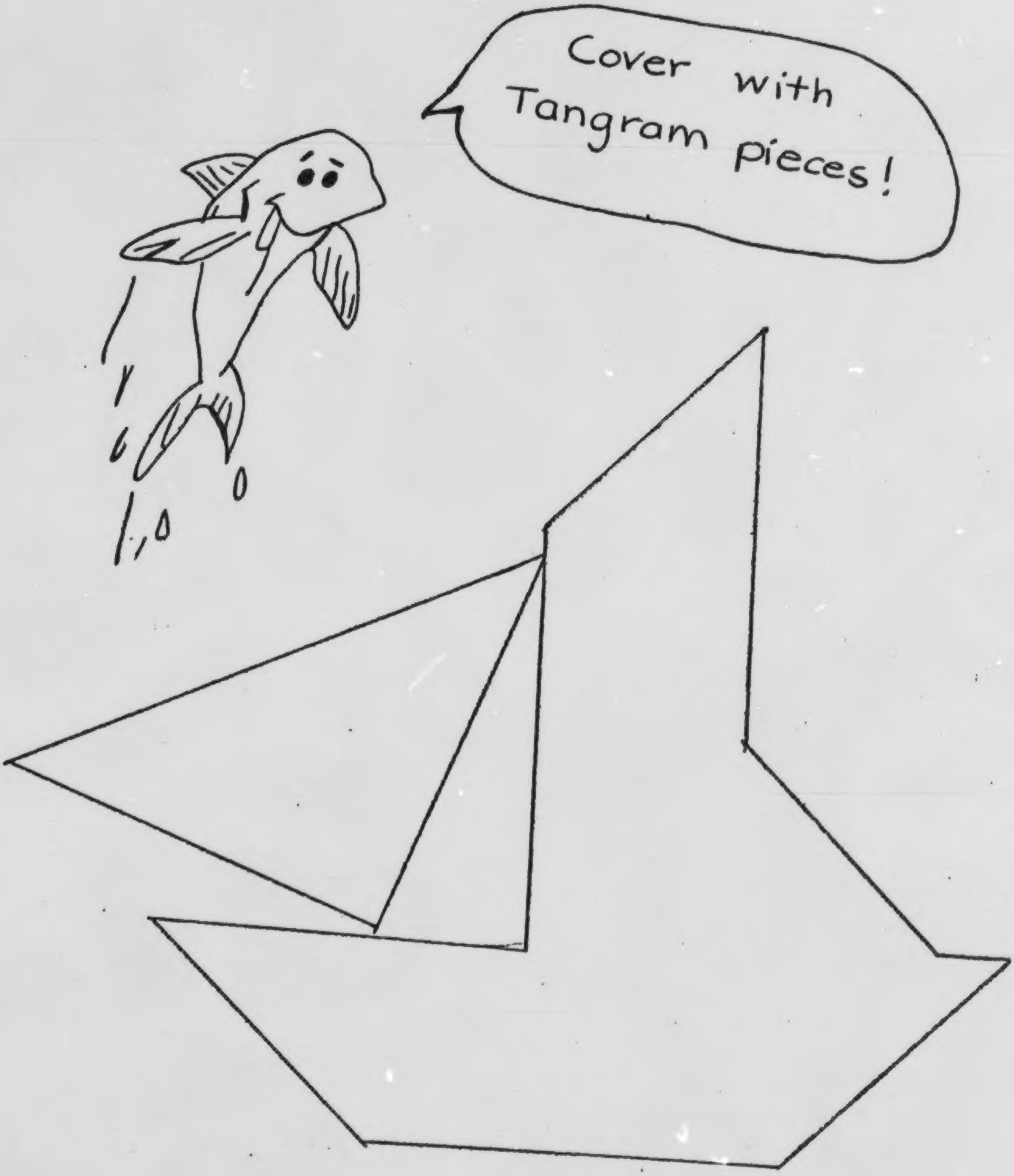
How many squares? ____

Evaluation Sample (Cont.)
Grade 1
Unit: Tangrams


Fit the Tangram Shapes!


What other letters of the alphabet can you make using all seven tangrams?

Evaluation Sample (Cont.)
Grade 1
Unit: Tangrams


Cover with Tangram pieces!

Unit Outline
Grade 1
Unit: Mobiles

Description of Unit: A mobile is defined as a delicately balanced construction or sculpture...having movable parts that can be set in motion by air currents or mechanical propulsion. The unit describes very simple ways in which children can experiment with balance by making constructions that are thought-provoking and attractive to look at. The Mobiles unit will prove to be difficult for some children and should be introduced near the end of the first grade school year. The unit on Primary Balancing should be completed prior to the unit on Mobiles. Mobile-making has been successful as an activity for individual children, small groups, or a whole class.

I. Balancing Individual Mobile Pieces

   A. Coat hanger mobile
   B. Plastic lid mobile

II. Assembling a Mobile From Pre-Cut Pieces

   A. Proper use of materials in kit
   B. Balancing an existing mobile system and predicting changes that will occur in a mobile when specified pieces are added
   C. Demonstrating the effect of changes in the shape, size, and/or type of materials upon a balanced mobile
   D. Comparing different kinds of mobiles

III. Independently Produce an Original Mobile Design

Suggested Activities
Grade 1
Unit: Mobiles

OBJECTIVE: To acquaint students with a variety of items that can easily be suspended and balanced

TITLE: "Coat Hanger Mobile"

SOURCE: Mobiles. ESS Teacher's Guide

OBJECTIVE: To produce a circular mobile using varying lengths of threads to suspend objects

TITLE: "Plastic Lid Mobile"

SOURCE: Mobiles. ESS Teacher's Guide

OBJECTIVE: After becoming acquainted with mobile pieces and balancing, to construct creatively a mobile from a beginning basic construction

TITLE: "Producing an Independent Mobile"

SOURCE: Mobiles. ESS Teacher's Guide

OBJECTIVE: To acquaint students with placement of suspending thread and its effect on the mobile piece

TITLE: "Balancing Individual Mobile Pieces on a Hook"

SOURCE: Mobiles. ESS Teacher's Guide

Text Materials

Gateways to Science. McGraw-Hill, 1979.

Mobiles. ESS Teacher's Guide. McGraw-Hill, 1976.

Primary Balancing. ESS Teacher's Guide. McGraw-Hill, 1974.

Kits and Materials

ESS materials kit for Mobiles

Activity cards for Mobiles

Exemplary Activity
Grade 1
Unit: Mobiles

OBJECTIVE: To construct creatively a mobile

MATERIALS AND EQUIPMENT: ESS materials kit for Mobiles

PROCEDURE:

I. Working together

A. Decide what kind of shapes you want to hang. Cut them out. (The shapes may relate to a holiday or special occasion.)

B. Make holes in the objects and place them on hooks so that they are balanced. Then suspend the objects from a piece of yarn.

C. Use the longest reed and balance the reed so that it hangs evenly.

D. Place two or more suspended objects from the long reed and balance the mobile.

E. Continue assembling the mobile until there is one smaller reed suspended from the original longest reed.

II. Working independently

A. Allow children to choose additional lengths of string, additional objects, and additional sizes of reeds to construct a mobile of their own design.

B. Decorate the mobile as each child wishes.

Evaluation Sample
Grade 1
Unit: Mobiles

The teacher can evaluate each student by using the following questions as guidelines.

Has the student learned the following concepts presented in the unit:

1. Can the student balance each mobile piece?

2. Can the student predict changes that will occur in a mobile piece as it is moved?

3. Can the student balance an existing mobile?

4. Can the student answer the following questions:
   a. What effect will change of shape cause?
   b. What effect will change of size cause?
   c. What effect will change of type of material cause?

Unit Outline
Grade 1
Unit: Spinning Tables and Machines

Description of Unit: The ESS unit Spinning Tables can be integrated into a larger unit on Machines or used as a separate course of study. The unit includes a separate teacher's guide and materials kit that allow students to perform a wide variety of experiments with rotating tables. Teachers may want to place the spinning tables inside a large cardboard box to prevent the spinning objects from rolling across the classroom.

I. Many Things in Our World Move in a Circle

   A. Machines -- wheels
   B. The earth rotates in a circle every day
   C. The planets revolve around the sun in somewhat of a circle
   D. The behavior of things that move in a circle

II. Different Types of Patterns Can Be Created by a Spinning Table

   A. Observing patterns
   B. Predicting patterns
   C. The behavior of powders and liquids on a spinning table

III. Skills That Are Developed and Strengthened by Manipulating a Spinning Table and Various Objects

   A. Observing
   B. Predicting
   C. Experimenting
   D. Recording and interpreting data

Suggested Activities
Grade 1
Unit: Spinning Tables and Machines

OBJECTIVE: To observe the pattern formed when a variety of chalk marks is made on the rotating table

TITLE: "Chalk Activities on the Rotating Table"

SOURCE: Spinning Tables. ESS Teacher's Guide

OBJECTIVE: To observe/predict the movement of a variety of objects on the rotating table

TITLE: "Movement of Objects on the Rotating Table"

SOURCE: Spinning Tables. ESS Teacher's Guide

OBJECTIVE: To observe/predict the movement of liquids and powders in sealed containers

TITLE: "Movement of Liquids and Powders on the Rotating Table"

SOURCE: Spinning Tables. ESS Teacher's Guide

Resources
Grade 1
Unit: Spinning Tables and
Machines

Text Materials

Gateways to Science. McGraw-Hill, 1979.

Science, Understanding Your Environment. Silver Burdett, 1978.

Spinning Tables. ESS Teacher's Guide. McGraw-Hill, 1976.

Filmstrips

Filmstrips relating to machines and centrifugal force available from school libraries and IRC.

Kits

ESS materials kit for *Spinning Tables*

Exemplary Activity
Grade 1
Unit: Spinning Tables and
Machines

OBJECTIVE: To predict the motion of objects in relation to size; to predict the motion of objects in relation to position

MATERIALS AND EQUIPMENT: ESS teacher's guide and materials kit for Spinning Tables

PROCEDURE:

1. Ask a student to select two different size objects, large ball and small ball. The balls are positioned close together on the spinning table, and the students predict which object will move off the table first. Reverse the positions and encourage the students to try different positions and make predictions.

2. Ask a student to select two objects similar in size. Position them at various locations on the spinning table and predict which position will leave the table first.

Encourage the students to set up experiments using different objects/positions and to predict the outcome.

Evaluation Sample
Grade 1
Unit: Spinning Tables and
Machines

I. Learning Center approach

A. A class list can be attached to the center and each child can place a tally mark by his/her name when a turn at the spinning table has been completed.

B. Students can collect magazine pictures or draw pictures of objects in the environment.

II. Whole class or small group approach

Record individual responses to activities such as:

1. Ask students to predict the outcome of objects on the table before they spin the table.

2. Ask students to position objects so that a predicted outcome will occur.

Unit Outline
Grade 2
Unit: Green Plants -- Growing Seeds

Description of Unit: The second grade teachers in each elementary building will be given the ESS teacher's guide Growing Seeds and the necessary kit that includes various seeds and materials. Each child is given seeds and soil along with containers for growing their seeds. Children learn how best to grow their seeds by performing individual experiments and keeping their own records. Teachers may expand on these concepts through other meaningful discoveries relating to plants.

I. A Tree Is a Growing Plant

   A. Seasonal changes of autumn, winter, and spring
   B. Seeds
   C. Leaves
   D. Roots
   E. Stems and buds

II. A Trip to a Maple Sugar Factory

   A. Trees as food sources
   B. Tree sap
   C. Review living things
      1. Where the sap goes in autumn
      2. Winter dormancy of trees
      3. The importance of spring sunlight and cold nights to the flow of tree sap
      4. Tapping maple sugar trees; the history of maple sugar tapping and how it is done today

III. Plants in Autumn, Winter, and Spring

   A. Visit areas such as Metropolitan Park or the land laboratory to study and view different kinds of plants and wildflowers

IV. Plants We Eat

   A. Nutritional value of plants
   B. What parts of plants can be eaten: leaf, stem, root

V. Growing Seeds

   A. The necessity of water, soil, and sunlight
   B. Growing seeds by use of the hydroponic method
   C. Different ways seeds are dispersed: wind, animals, humans

Suggested Activities
Grade 2
Unit: Green Plants -- Growing Seeds

OBJECTIVE: Our relationship to trees and seeds; changes that take place in trees as the seasons change

TITLE: "A Tree Is a Growing Plant"

SOURCE: School library books available relating to trees

OBJECTIVE: To understand that trees are a valuable food supply; children take a field trip to Metropolitan Park to observe a maple sugar demonstration; trip arranged by science consultant

TITLE: "A Trip to a Maple Sugar Factory"

SOURCE: Maple Sugar cassette and slides, available in each elementary building to second grade teachers

OBJECTIVE: To become aware of changes that take place in plants; compare spring changes to autumn and winter changes; some teachers will want to focus on native wildflowers

TITLE: "Plants in Spring"

SOURCE: Teacher devised

OBJECTIVE: To understand that plants are a valuable food source to humans and other animals

TITLE: "Plants We Eat"

SOURCE: Teacher devised

OBJECTIVE: To note the differences and similarities among various seeds and plants; to become aware of how seeds are dispersed and reproduce

TITLE: "Let's Collect Some Seeds"

SOURCE: Teacher developed activity to be conducted at the Upper Arlington Schools' Land Laboratory

Resources
Grade 2
Unit: Green Plants -- Growing Seeds

Text Materials

Charlie Brown's Super Book of Questions and Answers. Scholastic Book Services, 1976.

A First Look at Leaves. Scholastic Book Services, 1972.

Gateways to Science. McGraw-Hill, 1979.

Growing Seeds. ESS Teacher's Guide.

The Life of Beans and Peas. ESS Teacher's Guide.

Roots Are Food Finders. Thomas Crowell, 1975.

Science, Understanding Your Environment. Silver Burdett, 1978.

Sunshine Makes the Seasons. Thomas Crowell, 1974.

Films -- Grandview Heights Public Library

Nature's Half Acre. Disney, 11 minutes.

Seasonal Changes in Trees. COR, 11 minutes.

Seed Dispersal. EBE, 11 minutes.

Why Plants Grow Where They Do. COR, 11 minutes.

Wildflowers. BFA, 11 minutes.

Kits and Materials

ESS materials kit for Growing Seeds

Maple Sugar Production, cassette and slides

Hydroponic seed kits

Exemplary Activity
Grade 2
Unit: Green Plants -- Growing
Seeds

OBJECTIVE: To make children aware of different characteristics of seeds; to become aware of how plants are reproduced

MATERIALS AND EQUIPMENT: The Growing Seeds kit that has been supplied to all second grade teachers; magnifying lens

PROCEDURE:

Give each student 3 seeds from each package of seeds in the kit and mix the seeds together into a pile. Ask each child to put the seeds into the following groups:

1. Find the seeds that are alike and put them into groups.
2. Group the seeds according to their color.
3. Group the seeds according to their shape.
4. Group the seeds according to their size.
5. Group the seeds according to their weight (estimate).

A. Discuss the concept that seeds from different plants will also be different.

B. Discuss seeds that are commonly eaten (corn, peas, beans, etc.).

C. Examine seeds with magnifying lens.

D. Ask students to identify some of the seeds.

E. Let students choose 5 seeds that they would like to plant. Give each child a container and potting soil. The name of the child and the types of seeds that are planted should be printed on the outside of the container.

F. Students should then carefully water the seeds and place them on the window ledge. Each child can be responsible to water their seeds every day or the teacher may choose a different person every day who is responsible for watering all of the seeds.

G. Students keep a journal and note daily changes which take place in their seeds.

Evaluation Sample
Grade 2
Unit: Green Plants -- Growing Seeds

This unit can best be evaluated through teacher observation and oral responses by children to teacher-directed discussions and problem solving. In addition, it appears to be very meaningful to children and parents if each child is required to maintain a plant journal during the duration of the plant unit. Each child should make regular observations of his/her growing plants and record this information in the journal. Such things as measuring the plants, recording amount of sunlight, temperature, and amount of water added to plants will be valuable to the student.

Unit Outline
Grade 2
Unit: Geology -- Rocks and Minerals

I. Characteristics of Rocks and Minerals

    A. Three groups of rocks -- sedimentary, igneous, and metamorphic
    B. Collecting rocks and minerals
    C. Limestone and the characteristics of shells

II. Uses of Rocks and Minerals

    A. In the home
    B. Outside the home

III. Erosion

    A. Processes -- wind, water, temperature, plants, and chemicals
    B. Soil and its formation

IV. The Work a Geologist Does

Suggested Activities
Grade 2
Unit: Geology -- Rocks and Minerals

OBJECTIVE: To discover characteristics of rocks and minerals

TITLE: "Rock Research: Displays of Rocks and Labeling"

SOURCE: Teacher. Need from science room: scales, rock books, tape measures, rulers, magnifying glasses, and assorted rocks. Need rocks brought in by children.

OBJECTIVE: To see that sand is broken bits of rock

TITLE: "Sand Pictures"

SOURCE: Teacher. Use 6" x 9" black construction paper. Draw a picture on paper. Outline with glue and sprinkle sand on glue.

OBJECTIVE: To understand geology as a career and hear an "expert" speak

TITLE: "Geologist Comes to the Classroom"

SOURCE: Geology Department at O.S.U. (A geology student or perhaps a parent connected with the department)
Check Community Resource File in office

OBJECTIVE: To see that rocks and minerals are made of crystals

TITLE: "Crystal Rock Gardens"

SOURCE: Teacher. Make one crystal garden for class and one for each child. Observe for about one week.

OBJECTIVE: To look for rocks

TITLE: "A Walk for Rocks"

SOURCE: Teacher-planned field trip. Use egg cartons to collect rocks.

OBJECTIVE: To choose interesting shapes and see figures or designs on rocks

TITLE: "Paper Weights"

SOURCE: Teacher directed. Choose a rock and add a little color with paint.

OBJECTIVE: To choose various shapes of rocks and realize they can be decorative

TITLE: "Gifts for Parents"

SOURCE: Child chooses one rock for each member of family, paints face on rock with fine brush, glues to piece of wood, and sprays with a sealer. Drill a hole at top and insert a small leather shoelace for hanging.

OBJECTIVE: To observe that rocks are used for commercial purposes and to observe different types of rocks

TITLE: "Visit to a Stone Company"

SOURCE: Teacher-planned field trip to Lang Stone Company, 178 Sycamore (west of High Street), phone 228-5489

OBJECTIVE: To discover shell collections and how shells are formed, to feel the "stony material," and to research many kinds of shells

TITLE: "Shell Displays, Labeling and Research"

SOURCE: Books about shells; collections brought in by children. Need scales, tape measures, rulers, and magnifying glasses.

Resources
Grade 2
Unit: Geology -- Rocks and
Minerals

Text Materials

Charlie Brown's Super Book of Questions and Answers. Scholastic Book Services, 1976.

Cormack. The First Book of Stones.

Crosby. Junior Science Book of Rock Collecting.

Dudley. Sea Shells.

Everybody Needs a Rock. New York: Charles Scribner and Sons, 1974.

Gans. Millions and Millions of Crystals. Thomas Crowell, 1973.

____. The Wonder of Stones.

Gateways to Science. McGraw-Hill, 1979.

Goldreich. What Can She Be? A Geologist.

Gouday. Houses From the Sea.

Murray. Seashell Collectors' Handbook and Identifiers.

Parker. Pebbles and Sea Shells.

Podendorf. The True Book of Pebbles and Shells.

Sauer. Seashell Towns.

Science, Understanding Your Environment. Silver Burdett, 1978.

White. All About Our Changing Rocks.

Wyler. Secrets in Stones.

Films -- Grandview Heights Public Library

Rocks and Minerals (10 min.) Illustrates three basically different kinds of rocks and demonstrates the manner of formation.

Transparencies

Our Changing Earth and Rocks and Minerals. Milliken transparency books, available in science room at each elementary building.

Exemplary Activity
Grade 2
Unit: Geology -- Rocks and Minerals

OBJECTIVE: To see that many rocks and minerals are made of crystals

MATERIALS AND EQUIPMENT: Charcoal briquets; pie tin or milk carton; 1/4 cup water, 1/4 cup salt, 1/4 cup liquid bluing, 1 tbls. ammonia

PROCEDURE:

Combine water, salt, bluing, and ammonia and stir well. Keep stirring as you pour this mixture on the charcoal. Pour food coloring on top of mixture -- 8 or 10 drops of red, blue, or green. Set aside where it will not be bumped. Leave overnight for the best results. If you want more crystals, just pour more water on it.

Evaluation Sample
Grade 2
Unit: Geology -- Rocks and Minerals

Children construct a small booklet out of paper that has been precut by teacher. The title of the booklet is chosen by the child, e.g. "Rock Book," "What I know About Rocks," "Rocks and Shells," etc.

The teacher writes several concepts on the chalkboard, such as:

a. How, when, and where are rocks used in your daily life?

b. Give examples of the three kinds of rocks.

c. Where and when can you find rocks?

d. Would you like to plan a career in this field?

e. What did you learn from the field trips, speakers, and films about rocks?

f. Write what you discovered from the research and experiments about rocks.

Children draw pictures and answer questions as best they can on each page, and the concepts are used only as a guide. The children should be encouraged to be creative with their pictures and writing.

Observation, comments, and notes from parents are also helpful as an evaluation tool.

Unit Outline
Grade 2
Unit: Air, Weather, and Seasons

I. Air Is in Many Places

   A. Soil
   B. Water
   C. Rocks
   D. Living things need air

II. Properties of Air

   A. Necessary for burning
   B. Weight
   C. Lighter than water
   D. Expands when heated
   E. Contracts when cooled
   F. Hot air rises
   G. Can be transferred
   H. Occupies space
   I. Exerts pressure
   J. Contains different substances

III. Air Works for Us

   A. Moves things
   B. Lifts things
   C. Dries things

IV. Uses of Air

   A. Balloons, swimming toys, etc.
   B. Automobile tires, bicycle tires, etc.

V. Wind Is Moving Air

   A. Causes clouds to move
   B. Changes weather

OBJECTIVE: To discover that air takes up space

TITLE: "Will the Napkin Get Wet?"

SOURCE: Air by Adler, 1962. Library book.
Air Is All Around You by Branley, 1962. Library book.
Air Is Real by Jim Handy. Filmstrip.
Let's Find Out About Air by Shapp, 1963. Library book.

OBJECTIVE: To discover that air exerts pressure

TITLE: "Air Pressure"

SOURCE: Air Pushes Against Things by Jim Handy. Filmstrip.

OBJECTIVE: To discover that air moves dirt into an electric sweeper

TITLE: "The Dirt Disappears!"

SOURCE: Let's Find Out About Air by Shapp, 1963. Library book.

OBJECTIVE: To discover that we can use air to help things float

TITLE: "What Makes Them Float?"

SOURCE: Air Helps Things to Float by Jim Handy. Filmstrip.
Let's Find Out About Air by Shapp, 1963. Library book.

OBJECTIVE: To discover that wind is moving air by observing the moving clouds, swaying branches, clothing of people, leaves on trees, pinwheels, direction of smoke

TITLE: "An Investigation of the Wind and Cloud Movement"

SOURCE: The Air. Filmstrip. School library.

OBJECTIVE: To make children aware of weather changes that take place gradually throughout the year

TITLE: "The Changing Weather"

SOURCE: Teacher. Necessary instruments and materials are found in science room.

Text Materials

Adler, Irving and Ruth. Air. 1962. School library.

Branley, Franklyn. Air Is All Around You. 1962. School library.

Concepts in Science, Red Book, "Molecules and Heat," "Silence and Sound." Harcourt, Brace, and Jovanovich, 1972.

Gateways to Science. McGraw-Hill, 1979.

Science, Understanding Your Environment. Silver Burdett, 1978.

Shapp, Martha and Charles. Let's Find Out About Air. 1963. School library.

Sunshine Makes the Seasons. Thomas Crowell, 1974.

Films -- Grandview Heights Public Library

Wind: A First Film

Filmstrips

The Air. 8234 Encyclopedia Britannica.

Air Around Us. SVE.

Basic Weather: Why Does the Wind Blow? SVE.

Jim Handy First Experiements With Air Series:
- 1041 Air Is Real
- 1042 Living Things Need Air
- 1043 Air Is Everywhere
- 1044 Air Pushes Against Things
- 1045 Air Helps Things to Float in Water

Introduction to Our Earth and Sun

True Book of Science Experiments. SVE.

Charts

"Air and Weather." Twelve Instructor Primary Science Concept Charts, F.A. Owen Publishing Co.

Exemplary Activity
Grade 2
Unit: Air, Weather, and
Seasons

OBJECTIVE: To discover that air takes up space

MATERIALS AND EQUIPMENT: Large vessel of water, glass tumbler, napkin, cork

PROCEDURE:

To show that air takes up space, wad up a paper napkin and press it into the bottom of a glass tumbler. Place the tumbler mouth downward into an aquarium or other large vessel of water. Remove it from the water and see that the napkin is still dry. There was no room for the water to get into the glass because it was already filled with air. Repeat the procedure but tip the tumbler after it is submerged. Point out bubbles of air escaping and water entering.

Repeat the experiment using a cork or object that will float on water. Push the inverted "empty" glass over the floating object. Note that the floating object is lower than the water around the container. Discuss and reinforce by letting children do "hands-on" experiments that are related to characteristics of air.

Evaluation Sample
Grade 2
Unit: Air, Weather, and
Seasons

1. Circle the things that need air to live.

   grass table dog sun desk glass

   people bushes chair cat bird trees

   plants car flowers weeds water dish

2. Name six places where we could find air.

   1. water 3. 5.

   2. 4. 6.

3. What things, that we use, can be filled with air?

   1. balloons 2. 3. 4.

4. What is the wind?

   ____

5. How can the wind be helpful to us? ______________________

   ____

   ____

6. How can the wind be harmful? ______________________

   ____

   ____

7. Circle the true sentences.

   A. Air is heavier than water.

   B. Wind causes clouds to move.

   C. Fire can burn without air.

   D. Air expands when cooled.

   E. Wind gives us changes in the weather.

   F. Air contracts when heated.

7. (Cont.)

G. Hot air rises.

H. Air takes up space.

I. Air contains dust.

J. Air cannot push against things.

K. Air helps things to float.

L. Living things do not need air.

M. Air can work for us.

Unit Outline
Grade 2
Unit: Butterflies and Moths

Description of Unit: The study of this unit will allow the children to observe the biological process of metamorphosis and to learn to care for and protect a living creature. Butterflies are particularly interesting to the students because of their beauty. An extension of the unit would include the study of moths, providing an opportunity for the children to compare these two similar creatures.

I. Distinguishing Between Butterflies and Moths

II. Observe and Record Physical Change

    A. Life cycle -- four stages from egg to adult
    B. Measure growth rate
    C. Length of each stage

III. Environmental Conditions

    A. Food
    B. Temperature
    C. Handling
    D. Releasing

IV. Major Body Parts

    A. Function
    B. Description

Suggested Activities
Grade 2
Unit: Butterflies and Moths

OBJECTIVE: To observe the life cycle of butterflies

TITLE: "Butterfly Garden"

SOURCE: Insect Lore Products
P.O. Box 1535
Shafter, California 93263

OBJECTIVE: Keep an illustrated diary or log to record observations, measurements, and predictions

TITLE: "Diary or Log"

SOURCE: Butterflies themselves

OBJECTIVE: To observe physical structures characteristic of insects

TITLE: "Butterflies"

SOURCE: Butterflies. ESS Teacher's Guide.

Text Materials

Butterflies. ESS Teacher's Guide.

Butterflies Are Beautiful. Lerner Publications Company, 1974.

Gateways to Science. McGraw-Hill, 1979.

Science, Understanding Your Environment. Silver Burdett, 1978.

The Travels of Monarch X. Rand McNally.

Films -- Grandview Heights Public Library

Life Cycle of Monarch Butterfly

Filmstrips

The Painted Lady Butterfly Filmstrip, Insect Lore Products. This filmstrip has been given to second grade teachers in each elementary building.

Kits

Butterfly Garden Kit. Includes a coupon for redeeming live butterfly larvae.

Exemplary Activity
Grade 2
Unit: Butterflies and Moths

OBJECTIVE: To observe life cycle, care for, and protect a living thing

MATERIALS AND EQUIPMENT: Live butterfly garden

PROCEDURE:

1. Send for live butterfly culture. A Butterfly Garden Kit will be distributed to each teacher by the science consultant.

2. Watch the caterpillars feed, spin silk, and grow.

3. Watch change from caterpillars to chrysalises.

4. Construct Butterfly Garden and watch butterflies emerge.

5. Observe, feed, and release the butterflies.

Evaluation Sample
Grade 2
Unit: Butterflies and Moths

A written test does not appear to be appropriate for this unit. Teacher observation is the primary means of evaluation. Classes should also do a substantial amount of creative writing with this unit.

After the butterflies have been released, the class may review or culminate the unit with the following project:

Illustrate the life cycle of a butterfly on a paper plate. At "twelve o'clock" the children can glue a grain of rice on a leaf (real or student made) to represent the egg. At "three o'clock" the children use the paper from a straw (after accordian pleating it before removal) to represent the caterpillar. At "six o'clock" the students hang the chrysalises that have either been made from clay or Saran Wrap. At "nine o'clock" the children place the emerged butterfly -- wings spread.

The children will love this activity and it makes a nice display.

Also the journal or diary that the children keep will aid in teacher evaluation.

Unit Outline
Grade 2
Unit: Exploration of Outer Space

I. The Exploration of Outer Space

  A. Benefits to mankind
  B. Space exploration that has been done in the past

II. Problems Associated With Exploration of Space

  A. Physical problems such as gravity, fuel, and rocket design
  B. Other problems such as cost and political support

III. The Progress of Space Exploration

  A. The beginning of a new era: Sputnik
  B. United States space exploration
    1. Satellites
    2. Mercury space vehicle -- one-man spacecraft
    3. Gemini space vehicle -- two-man spacecraft
    4. Apollo space vehicle -- three-man spacecraft
  C. The first Americans in outer space
    1. Alan Shepard
    2. John Glenn
  D. Trip to the moon
    1. The Eagle has landed.
    2. Astronauts Neil Armstrong, Buzz Aldrin, Michael Collins
  E. Space probes to planets within our solar system
    1. Information that we have recently discovered about the planets within our solar system
    2. Problems associated with space probes to the planets
  F. Artificial satellites such as Skylab
    1. Living and working in space over long periods
    2. Problems -- what caused Skylab to fall from orbit?
    3. Four crews
  G. Space shuttle
    1. More economical
    2. Testing
    3. Possibilities

IV. Understanding Problems Faced by Astronauts Training and Living in Space

  A. Life support system
    1. Food
    2. Water
    3. Oxygen
    4. Air pressure
    5. Gravity
    6. Temperature
    7. Communication
    8. Exercise

  B. Training in simulators: NASA -- Houston (Johnson Space Center)

V. Understanding Sequence and Mechanics of Flights

- A. Countdown
- B. Blast off -- rockets
- C. Orbiting
- D. Re-entry
- E. Splashdown
- F. Recovery -- ship, flotation collar, basket

Suggested Activities
Grade 2
Unit: Exploration of Outer Space

OBJECTIVE: To understand why different planets complete orbits at different times

TITLE: "Space Walk Around Chair"

SOURCE: A Book of Outer Space, Thomas Crowell

OBJECTIVE: To understand action reaction -- rocket blastoff

TITLE: "Volleyball Toss With Scales"
(Throw, measure push on scales)

SOURCE: Science, Understanding Your Environment, Silver Burdett
Looking Into Science, American Book Company

OBJECTIVE: To understand size relationship among planets

TITLE: "Personal Solar System Model"
(Grass seeds, beans, marbles, etc.)

SOURCE: Probing Into Science, American Book Company
Science, Understanding Your Environment, Silver Burdett

OBJECTIVE: To understand why space probes are aimed at a spot where planet will soon be

TITLE: "On Target"
(Use two balls)

SOURCE: Probing Into Science, American Book Company
A Book of Outer Space, Thomas Crowell

OBJECTIVE: To understand how craters are made on the moon

TITLE: "Why Craters?"

SOURCE: The Moon, Searching Into Science. American Book Company

OBJECTIVE: To understand how rovers work; try on obstacle course

TITLE: "Building a Mars Roving Vehicle"

SOURCE: Space Flight, Scholastic Fun Fact Book, 1976

OBJECTIVE: To understand why satellites stay in orbit

TITLE: "Satellite in Orbit"

SOURCE: Space Flight, Scholastic Fun Fact Book, 1976

Resources
Grade 2
Unit: Exploration of Outer Space

Text Materials

Astronauts in Training. A Colby Book. New York: Coward, McCann and Geoghegan, 1969.

A Book of Outer Space for You. Thomas Crowell, 1970.

Branley, Franklyn M. Let's Read and Find Out Science Book, "Rockets and Satellites," "Gravity Is a Mystery," "The Moon Seems to Change," "The Sun: Our Nearest Star," "What the Moon Is Like." Toronto: Fitzhenry and Whiteside Limited, 1970.

Charlie Brown's Second Super Book of Questions and Answers. New York: Random House, 1977.

Concepts in Science. Harcourt Brace Jovanovich, Inc., 1972.

Daytime Astronomy. ESS Teacher's Guide, 1972.

Exploring the Solar System, Probing Into Science. American Book Company, 1965.

Exploring Space, Searching in Science. American Book Company, 1965.

Fuchs, Erich. Journey to the Moon. A Seymour Lawrence Book. New York: Delacorte Press, 1969.

Gateways to Science. McGraw-Hill, 1979.

Living in Space, Probing Into Science. American Book Company, 1965.

Martin, Bill Jr. The Eagle Has Landed. Holt, Rinehart and Winston, Inc., 1970.

The Moon, Searching in Science. American Book Company, 1965.

Munch, Theodore W., Ed.D. What Is a Rocket. Chicago, Benefic Press, 1961.

Rockets, Looking Into Space. American Book Company, 1965.

Rubinger, Michael. I Know an Astronaut, A Community Helper Book. New York: G.P. Putnam's Sons, 1972.

Science, A Book for Young Readers. Licensee Banner Press, Inc., 1974 and 1977.

Text Materials (Cont.)

Science, Understanding Your Environment. Silver Burdett, 1978.

Space Flight, The Scholastic Fun Fact Book. Usborne Publishing, 1976.

Wheat, Janis Knudsen. Let's Go to the Moon. National Geographic Society, 1977.

Where Was the Moon. ESS Teacher's Guide, 1965.

Worden, Col. Alfred M. A Flight to the Moon. New York: Doubleday and Company, Inc., 1974.

Films -- Grandview Heights Public Library

Eagle Has Landed -- Flight of Apollo 11

Exploring the Moon

First Men Into Space

Giant Step in Communication

The Universe: Flight to the Stars

Transparencies

Space Exploration -- Milliken transparency book, available in science room at each elementary building

Pamphlets

United States Government Printing Office, Washington C.C. 20402
(Send for list)

Exemplary Activity
Grade 2
Unit: Exploration of Outer
Space

OBJECTIVE: To understand the concept of action and reaction (rocket racers)

MATERIALS AND EQUIPMENT: Balloons for whole class (available in science room), string, two paper clips or tape, chair

PROCEDURE:

The teacher should present a whole group demonstration first.

Attach a string to a chair and then elevate string to a higher point and attach to wall, table, etc.

Blow up a balloon and seal the end with tape.

Open the paper clip to form a hook. Tape one end of both hooks onto balloon and hook other end onto string.

Release tape over opening and watch the balloon rocket climb up the string.

A. Have individuals try releasing air from their balloons.

B. Have launcing races.

C. Who can make theirs go higher?

D. How?

E. Why?

Evaluation Sample
Grade 2
Unit: Exploration of Outer Space

Space Stumpers

Put a T in the space if the sentence is true, an F if it is false.

1. _____ The sun travels around the earth.
2. _____ The earth rotates on its axis and this causes day and night.
3. _____ The earth revolves around the sun once a year and this causes the seasons.
4. _____ The earth is the only planet with gravity.
5. _____ Neil Armstrong was the first man to walk on the moon.
6. _____ The moon makes its own light.

Put in the right order, 1, 2, 3, 4, 5, 6.

_____ launching
_____ orbiting
_____ countdown
_____ splashdown
_____ re-entry
_____ recovery

Match the planets to the correct phrase.

1. Jupiter _____ we know there is life here.
2. Pluto _____ has the most moons
3. Venus _____ has rings
4. Mercury _____ is farthest from the sun
5. Mars _____ is closest to the sun
6. Saturn _____ the red planet
7. Earth

Evaluation Sample (Cont.)
Grade 2
Unit: Exploration of Outer
Space

Use the words at the bottom to fill in the blanks.

1. A man who is launched into space is called an ____________________.

2. Astronauts ride in a __________________________.

3. America's first man to orbit the earth was ____________________.

4. On Apollo missions one of the crew is called the _______________ pilot.

5. Space flights are launched from _______________ _________________.

6. The first U.S. satellite launched was called the ___________________.

7. Picking up the returned spacecraft from the ocean is called _______________.

8. Saturn V launched Apollo to the _______________.

9. _______________ ________________ was the first man to step onto the moon.

10. The first manned flight to land on the moon was _____________________.

11. There has been a docking of spaceships from two different countries, the U.S. and ___________.

12. The astronauts drove a ___________ _________________ on the moon to explore.

13. ____________ ______________ was the first U.S. man to walk in space.

John Glenn
Ed White
Neil Armstrong
command
capsule

lunar rover
Russia
Explorer
Apollo 11

recovery
moon
astronaut
Cape Kennedy

Put an X beside the best answer.

1. A heavenly body that makes its own heat and light. ____ planet
____ satellite ____ star

2. The path a planet or satellite moves in. ____ orbit ____ comet
____ re-entry

3. The part of the spacecraft where the astronauts live. ____ lunar module
____ command module

4. The part of the spacecraft that lands on the moon. ____ lunar module ____ service module ____ command module

5. The part of the spacecraft that carries batteries for electric power needed for air conditioning, heating, and lighting. ____ lunar module ____ command module ____ service module

6. The lunar module that landed on the moon. ____ Columbia ____ Eagle ____ Viking

7. The force that pulls on things. ____ electricity ____ gravity ____ wind

8. When two spaceships join together. ____ re-entry ____ docking ____ launching

9. A machine that makes the astronauts believe they are really in space. Used to train astronauts. ____ satellite ____ simulator ____ helicopter

10. America's first space station. ____ Shuttlecraft ____ Skylab ____ Sputnik

1. Why would a teacher like to send a noisy class into space?

2. What kinds of clothes would you wear on Pluto?

3. Tell me or draw your favorite part of the space unit.

4. Do you know of three things the astronauts left on the moon? Draw a picture of one of them.

Weight on the Moon

How much do you weigh on the moon?

Earth	Moon
50 lbs.	8 lbs.
60 lbs.	10 lbs.
70 lbs.	11 lbs.
80 lbs.	13 lbs.
90 lbs.	14 lbs.
100 lbs.	16 lbs.

Unit Outline
Grade 2
Unit: Match and Measure

Description of Unit: All elementary buildings contain the Match and Measure learning kit and teacher's guides that are available to second grade teachers. The unit suggests interesting activities for primary children to learn about measurement in an informal way, using measuring sticks, tape measures, calipers, measuring wheels, and a geo board.

I. Compare a Quality

A. Is one thing "more than" or "less than" another?
B. Considering two containers, which one holds more than another?
C. Compare weights of two or more objects.

II. Compare Objects Using a Nonstandard Unit

A. Use strings to compare lengths.
B. Use blocks to compare weights.
C. Use a container to compare volume.

III. Compare Objects Using a Standard Unit

A. Ruler
B. Balance
C. Cup

IV. Compare Changes in Size Over a Given Time

A. Use a standard measurement.
B. Record changes.

V. Comparing Parts to the Whole

A. Use strings.
B. Use containers.

VI. Comparing Area

A. Replicate a pattern using blocks.
B. Make maps of a classroom.

VII. Practical Application

A. Cooking
B. Building
C. Drawing

Suggested Activities
Grade 2
Unit: Match and Measure

OBJECTIVE: Comparing heights of towers made from Cuisenaire Rods or other building blocks

TITLE: "Building Towers"

SOURCE: Teacher devised

OBJECTIVE: Comparing parts of the body (i.e. waist, wrist, ankle, head)

TITLE: "Measuring Parts"

SOURCE: ESS teacher's guide Match and Measure

OBJECTIVE: Comparing parts to a whole

TITLE: "Let's Bake"

SOURCE: Teacher devised

OBJECTIVE: Comparing size over a given time

TITLE: "How Plants Grow"

SOURCE: ESS teacher's guide Match and Measure

OBJECTIVE: Comparing objects using a standard unit of measurement

TITLE: "What Will Balance?"

SOURCE: ESS teacher's guide Match and Measure

OBJECTIVE: Comparing area

TITLE: "Be a 'Copy-Cat'"

SOURCE: Cuisenaire Rods Activity Cards

OBJECTIVE: Recording changes

TITLE: "Shadow Play"

SOURCE: ESS teacher's guide Match and Measure

OBJECTIVE: Comparing a quality

TITLE: "Fingers, Hands, and Feet"

SOURCE: ESS teacher's guide Match and Measure

Text Materials

Cuisenaire Rods and Activity Cards

Froman, Robert. Bigger and Smaller. New York: Thomas Y. Crowell Co.

Gateways to Science. McGraw-Hill Book Company, 1979.

Match and Measure. ESS Teacher's Guide.

Myller, Rolf. How Big Is a Foot? New York: Reehl Litho, Inc.

Science for Tomorrow's World. MacMillan, 1966.

Science Is Learning. Scott, Foresman and Co., 1965.

Science, Understanding Your Environment. Silver Burdett Co., 1978.

Kits

ESS materials kit for Match and Measure

Exemplary Activity
Grade 2
Unit: Match and Measure

OBJECTIVE: Comparing area -- "Be a 'Copy Cat'"

MATERIALS AND EQUIPMENT: Cuisenaire Rods, centimeter graph paper, crayons

PROCEDURE:

1. Give a child one kit of Cuisenaire Rods.
2. Ask the child to make a flat design with the rods. The orange rods form the outside boundaries. Fill in this boundary as you wish using other colored rods.
3. Give the child a sheet of centimeter graph paper.
4. The child is then to transfer the same pattern onto the paper, coloring in the proper color.
5. Children sometimes have to lay the rods directly on the graph paper to get proper size.

OBJECTIVE: Comparing parts to a whole -- "Let's Bake"

MATERIALS AND EQUIPMENT: Refrigerated cookie rolls, cookie sheets, knives, oven, and timer

PROCEDURE:

Directions for baking the cookie rolls are on each package. Children divide the cookie rolls into halves. Slices are then cut from each half. Each slice is cut into fourths. Each piece is placed on a cookie sheet and baked for the recommended time.

Evaluation Sample
Grade 2
Unit: Match and Measure

The basic evaluation of this unit will take place through teacher observation.

Some evaluation of measurement using a standard unit can be done through the use of the Scott, Foresman Mathematics Workbook for grade 2.

Unit Outline
Grade 2
Unit: Energy and Static
Electricity

I. Static electricity is electricity that is at rest. Static (not moving) differs from current type electricity in its origin and use.

II. Static electricity can be made by friction -- the rubbing together of objects.

III. Static electricity produces electrical charges that have certain properties and characteristics.

IV. Static electricity is a form of energy.

Suggested Activities
Grade 2
Unit: Energy and Static
Electricity

OBJECTIVE: To illustrate that rubber produces static electricity

TITLE: "Making Static Electricity with Balloons"

SOURCE: Material available in science room

OBJECTIVE: To provide "hands-on" experiences through direct experimentation with static electricity principles

TITLE: "Classroom Experiments with Static Electricity"

SOURCE: Materials available in science room

OBJECTIVE: To acquaint students with properties of static electricity
    a. Like charges repel and opposite charges attract
    b. The electrical charges are a result of small units called electrons

TITLE: "Static Electricity Has Two Different Kinds of Charges"

SOURCE: Material available in science room

Text Materials

Adler, Irving. Electricity in Your Life.

Charlie Brown's Super Book of Questions and Answers. Scholastic Book Services, 1976.

Electricity. Boy Scouts of America, merit badge pamphlet.

Fercivolo, Rocio. Junior Science Book of Electricity.

Freeman, Ira M. All About Electricity.

Gateways to Science. McGraw-Hill, 1979.

Morgan, Alfred. A First Electricity Book for Boys.

Science for You, Level 2, "Electricity by Rubbing." Ginn.

Science, Understanding Your Environment. Silver Burdett, 1978.

Films -- Grandview Heights Public Library

I'm No Fool With Electricity. Disney, 8 minutes.

Filmstrips -- School Library

Experiments With Static Electricity

Static Electricity

Exemplary Activity
Grade 2
Unit: Energy and Static
Electricity

OBJECTIVE: To provide a variety of learning experiences with respect to static electricity

Experiment #1

MATERIALS AND EQUIPMENT: Fur, glass or rubber rods, stand, pith balls

PROCEDURE:

The students are to rub the rods briskly with a piece of fur. Then hold the "charged" rod close to one of the pith balls. Observe and record any reactions.

Experiment #2

MATERIALS AND EQUIPMENT: Fur, rods, faucet (or a means of producing a thin stream of water)

PROCEDURE:

Rub a rod briskly with a piece of fur and then hold it close to a stream of water. The rod must not touch the water. Observe and record.

Experiment #3

MATERIALS AND EQUIPMENT: Clear plastic case with lid, tissues, and fur

PROCEDURE:

Tear up several sheets of tissue and place them in a plastic case with the lid on. Rub the lid briskly with the fur. Observe and record any reactions.

Experiment #4

MATERIALS AND EQUIPMENT: Comb

PROCEDURE:

On a cold dry day, rub a comb quickly through the hair several times. Then touch the dry palm of the hand lightly with the comb. One may be able to hear, see, and feel the effects of the charges of static electricity.

Evaluation Sample
Grade 2
Unit: Energy and Static
Electricity

The evaluative instrument of this unit will be primarily of two types:

A. Performance by the child with respect to activities, experiments, procedures, and use of materials;

B. Oral responses by the child relating to concepts and percepts.

Unit Outline
Grade 2
Unit: Geo Blocks

Description of Unit: Geo Blocks provides activities to aid the development of thinking skills in children, emphasizing problem-solving skills and attitudes that will be useful in a wide variety of situations. Children explore the problems of classification and become skillful in dealing with the relationship between classes.

I. Building Structures

  A. Symmetry -- line of axis, bilateral
  B. Congruence
  C. Equal volumes

II. Classification

  A. Grouping based on properties
  B. Inferring rules used for grouping

III. Measurement

  A. Determination of volumes

IV. Investigation of Slopes

  A. Construction of smooth ramps
  B. Steepness of slopes
  C. Identification of blocks that build good ramps

V. Investigation of the Two-Dimensional Aspects of Blocks

  A. Drawing outline views of structures
  B. Identification of blocks from shadow shapes and pictures

VI. Identification and Description of Geo Blocks

  A. Oral description of blocks by vertices, face shapes, and edges

VII. Application of Mathematical Concepts Using Geo Blocks

  A. Determination of total surface areas
  B. Identification of fractional relationships

Suggested Activities
Grade 2
Unit: Geo Blocks

OBJECTIVE: To solve problems involving classification and establish relationships among a variety of geometric shapes

TITLE: "Guess My Rule"

SOURCE: ESS Unit -- Geo Blocks. See teacher's guide, pp. 12-13.

OBJECTIVE: To investigate the two-dimensional aspects of blocks

TITLE: "Two-Dimensional Blocks"

SOURCE: ESS Unit -- Geo Blocks. See teacher's guide, pp. 11-12.

OBJECTIVE: To investigate volume relationships between larger and smaller blocks

TITLE: "Using Boxes"

SOURCE: ESS Unit -- Geo Blocks. See teacher's guide, p. 13.

Resources
Grade 2
Unit: Geo Blocks

Text Materials

Gateways to Science. McGraw-Hill, 1979.

Piaget and Inhelder. *The Child's Conception of Space*. New York: Norton, 1967.

Science, Understanding Your Environment. Silver Burdett, 1978.

ESS teacher's guide -- *Geo Blocks*.

Related ESS units and teacher's guides:
- *Tangrams*
- *Match and Measure*
- *Primary Balancing*
- *Attribute Games and Problems*
- *Pattern Blocks*

Kits

ESS materials kit and cards for *Geo Blocks*

Exemplary Activity
Grade 2
Unit: Geo Blocks

OBJECTIVE: To solve problems involving classification and establish relationships among a variety of geometric shapes

MATERIALS AND EQUIPMENT: ESS Unit -- Geo Blocks

PROCEDURE:

(This game should be played after the children have manipulated the blocks for a time and are quite familiar with them.)

1. Select two or more blocks that belong together for some reason. Ask a classmate to guess why these blocks belong together. If necessary, give a clue by showing other blocks that do not belong in the group.

Expand above activity by having children find other blocks that belong with the first two selected.

2. Sort blocks according to shape of whole block.

3. Sort blocks according to shape of the faces of the blocks.

4. More difficult classification activities can be found on pp. 17-18 of the teacher's guide.

Evaluation Sample
Grade 2
Unit: Geo Blocks

A written test does not appear to be appropriate for this unit. Teacher observation is the most appropriate means of evaluation. The development of the skills and concepts listed in the beginning of the teacher's guide should be observed and evaluated by the teacher.

Unit Outline
Grade 3
Unit: The Earth's Features

I. Physical Features of the Earth

   A. Mountains and volcanoes
   B. Oceans
   C. Deserts

II. Constant Change -- Erosion

   A. Work of water and ice
   B. Work of sun and heat
   C. Work of wind

III. Adaptation to Environment

   A. Plant and animal life on earth -- how it adapts
   B. Climate -- how it affects plants and animals

IV. Exploration

   A. Need to explore ways to develop natural resources for the future

OBJECTIVE: Models the physical features of the earth by making a salt map showing mountains, deserts, oceans, plains, and plateaus

TITLE: "Features of the Earth"

SOURCE: Teacher

OBJECTIVE: Constructs clay models of folding, faults, and volcanoes

TITLE: "Mountain Formations"

SOURCE: Teacher

OBJECTIVE: To have students become familiar with the major deserts, oceans, mountain ranges, and volcanoes of the world

TITLE: "Map Reading"

SOURCE: Teacher

OBJECTIVE: Makes dioramas of desserts, mountains, oceans, or volcanoes to show understanding of these environments

TITLE: "Dioramas"

SOURCE: Teacher

Text Materials

Beauchamp and Calland. Science Is Exploring, Teacher's Edition. Scott Foresman, 1961, pp. 85-104.

Gateways to Science. McGraw-Hill, 1979.

Schneider, H. and N. Science Far and Near, Teacher's Edition. Heath, 1965, pp. 211-279.

Schultz, C. Charlie Brown's Second Book of Questions and Answers. Scholastic Book Services.

Schultz, C. Charlie Brown's Super Book of Questions and Answers. Scholastic Book Services.

Science, Understanding Your Environment. Silver Burdett, 1978.

Films -- Grandview Heights Public Library

Americans on Everest

Causes of the Seasons

Dinosaur Age

Earthquakes and Volcanoes

Eruption of Kilauea

Eternal Change: Story of a Mountain

Face of the Earth

Geological Work of Ice

Globe and Our Round Earth

Grand Canyon

Life in the Desert

Mountains, Plains, and Plateaus

Mysteries of the Deep

Rocks and Minerals

Films (Cont.)

Sixth Continent

Treasures of the Earth

Two Deserts -- Sahara and Sonora

What Is a Desert

Winter Geyser

Yosemite National Park

Filmstrips -- School Library

Earth's Diary

Glaciers and Their Work

How Our Earth Began

The Ice Age

Our Changing Earth

Our Home the Earth

The Seas About Us

The Story of Glaciers

Story of Mountains

Volcanoes in Action

Water and Its Work

Work of Running Water

Work of the Wind

Materials

Landform model

Exemplary Activity
Grade 3
Unit: The Earth's Features

OBJECTIVE: A "hand's on" activity to show an understanding of the main "features" of the earth

MATERIALS AND EQUIPMENT: Salt, flour, and water for a salt map; poster paint; a tray of some type to use as a base for the salt map

PROCEDURE: "Your Own Island"

You are sailing on an imaginary ocean one bright, sunny afternoon. Suddenly, the skies grow dark and stormy and you and your small boat are washed onto what looks to be an island. You take shelter for the night but plan to explore the island in the morning. You awake, catch a fish for your breakfast, and then begin to explore. On your first day, you find that you are in a valley between two mountain ranges. A river runs through the valley and you decide to find its source. You also want to get an overview of the land you are on, so you begin to journey up a nearby mountain. The climb takes you three days, but you had planned on this climb and brought some food and blankets.

When you reach the top of the mountain, you find you can see for miles in all directions. You now know you are on an island.

On one side of the island there is a grassy plain that comes to the foot of these mountains, and on the other side of the mountains is a small desert. You can see much better now the valley that lies between the mountains and the river that rushes through the valley. You can also see a lake high up in the mountains that is the source of the river that runs to the ocean.

You decide to make a map of what you see. When you make a salt map, you use colors to show earth features:

mountains -- brown

deserts -- yellow

plains and valleys -- green

water -- blue
  ocean
  river
  lake

You will need to put this key on your salt map.

This activity can be expanded to integrate language arts (reading, spelling, creative writing), math (use specific measurements), and art (using color to depict certain things).

Evaluation Sample
Grade 3
Unit: The Earth's Features

Using the following word bank, the teacher makes up sentences or questions. The student will write the word or words that are appropriate.

erosion
Sahara
oasis
Atlantic
Kilauea
core
rotation
magma
stalactite
igneous

Pacific
Rockies
fossil
glacier
Sonora
Ring of Fire
Mt. Everest
sedimentary
lava
revolution

oasis
Indian
metamorphic
seven
North America
continent
folding
moraine
fault
cave

An example would be:

Question: What are two famous deserts you have learned about?

Answer: Sahara and Sonora

Unit Outline
Grade 3
Unit: Energy and Conservation -- Electricity

I. Energy and How It Can Help Us

  A. Work -- what it is
  B. Energy for our bodies and where it comes from
  C. Energy all around us
  D. Energy for machines and where it comes from

II. Energy for Today and Tomorrow

  A. Today's energy sources and why we use them
  B. Major energy sources used today -- nonrenewable
  C. New energy sources for the future

III. Energy Conservation

  A. The importance of conserving energy
  B. What we can do to conserve energy
  C. The importance of everyone conserving energy

OBJECTIVE: To make children aware of energy-related careers

Children pantomine a type of work while other children try to guess the profession.

TITLE: "What's My Line?"

SOURCE: A Teacher's Introduction to Energy and Energy Conservation. Ohio Department of Education, 1975, pp. 45-46.

OBJECTIVE: To place importance on food as the source of our energy

Children keep a daily log of food consumed for one week in order to emphasize that the energy our bodies need comes from the food we eat.

TITLE: "The Human Machine"

SOURCE: Teacher developed

OBJECTIVE: To focus on the use of electricity and other types of energy being used in the community

Children survey home and school to find examples of energy being used in their immediate environment. Information is recorded in a chart showing place energy is used, source, and way it is being used.

TITLE: "EE" (Energy Environment)

SOURCE: Teacher developed

OBJECTIVE: To show the relationship between machines and energy

Students build a lever, a wheel and axle, and a pulley.

TITLE: "Simple Machines"

SOURCE: Simple Machines. Discovery Kit

OBJECTIVE: To use hands-on experiments for demonstrating some uses of electrical energy

TITLE: "Is Your Circuit Complete?"

SOURCE: Batteries and Bulbs. ESS Teacher's Guide
Experiences in Science: Batteries. Teacher's Guide

OBJECTIVE: To make children aware of the need for conservation and the consequences that result from wasting our resources

Students use a given number of pieces of paper for the entire class for one week. When the supply is "used up," children discuss the outcome, the solution to the present problem, the meaning of a nonrenewable resource, and the future planning for use of a nonrenewable resource.

TITLE: "Then There Was None"

SOURCE: Teacher developed

OBJECTIVE: To demonstrate the potential use of wind as an energy source and its relationship to electricity

Children make a simple windmill (4 or 5 popsicle sticks with cardboard fan paddles glued to the sticks). Drive the windmill with a fan. Discuss what work the wind may do for us that it is not being used to do today.

TITLE: "Wind Energy"

SOURCE: A Teacher's Introduction to Energy and Energy Conservation. Ohio Department of Education, 1975, p. 52.

OBJECTIVE: To let children observe a result of solar energy

Children use cold water and teabags to make "iced tea" using the sun to cause the tea to interact with the water. Discuss what work the sun may do for us that it is not being used to do today.

TITLE: "Solar Tea"

SOURCE: Teacher developed

OBJECTIVE: To develop an awareness of the need for conserving electrical energy

Children draw a map of their home. They place an "X" at the place where a light switch is in each room. They place an "O" at each place where there is an outlet. For one week, they check electric lights and appliances at least 3 times a day for wasted energy. Bar graph results. Estimate how long each appliance was on beyond the time it was actually needed.

TITLE: "X or O = Saved Energy"

SOURCE: A Teacher's Handbook on Energy. Colorado Department of Education.

OBJECTIVE: To give children the experience of learning the energy attitudes of other people

TITLE: "Your Opinion, Please"

SOURCE: A Teacher's Handbook on Energy. Colorado Department of Education.

OBJECTIVE: To make children more aware of the sources and uses of energy within their community

Develop with children energy conservation checklists that could be used for 1. maintenance of home and school (to prevent heat loss) 2. utilities 3. transportation, and 4. heating and cooling. Use the checklists to discuss ways energy is being conserved or can be conserved.

TITLE: "Have You Checked Energy Use?"

SOURCE: A Teacher's Handbook on Energy. Colorado Department of Education.

Resources
Grade 3
Unit: Energy and Conservation -- Electricity

Text Materials

Electricity. Follett Publishing Company, 1967.

Gateways to Science. McGraw-Hill, 1979.

Schultz, C. Charlie Brown's Second Super Book of Questions and Answers. Scholastic Book Services, 1977.

Schultz, C. Charlie Brown's Super Book of Questions and Answers. Scholastic Book Services, 1976.

Science, Understanding Your Environment. Silver Burdett, 1978.

Tannenbaum, Harold E., at al. Batteries. McGraw-Hill, 1967.

A Teacher's Handbook on Energy. Colorado Department of Education, Denver, Colorado, 1975.

A Teacher's Introduction to Energy and Energy Conservation. Ohio Department of Education, Columbus, Ohio, 1975.

Films -- Grandview Heights Public Library

Electricity From Chemicals, 14 min.

Energy: A Matter of Choices, 22 min.

Learning About Electric Current, 15 min.

Filmstrips

Filmstrips relating to energy and conservation are available from school libraries.

Transparencies

Electricity. Milliken transparency book, available in building's science room.

Magazines

"The Best Present of All," reprint from Ranger Rick's Nature Magazine, April 1974, May/June 1974.

"Mickey Mouse and Goofy Explore Energy." Walt Disney Educational Media Co., 500 Buena Vista St., Burbank, CA 91521. (Additional copies obtained from Public Affairs Dept., Exxon, U.S.A., P.O. Box 2180, Houston, TX 77001.)

Booklets

Natural Gas Serves Our Community.
What Is Gas?
Obtained from Educational Services, American Gas Association, 1515 Wilson Blvd., Arlington, VA. Available from gas company.

Kits and Materials

"A Collection of Resources for the Educator Concerned About Energy." Compiled by the Environmental Studies Center for the Ohio Energy Conservation Workshops in November 1975.

Columbus and Southern Ohio Electric Co., 215 N. Front Street, Columbus, OH 43215 provides materials to teachers.

Batteries, bulbs, wire, miniature motors, buzzers

Exemplary Activity
Grade 3
Unit: Energy and Conservation -- Electricity

OBJECTIVE: To enable all children in the school to become more aware of energy and the need for conservation; as a culminating activity, the third grade children can plan an "Energy Awareness Day" for the school

MATERIALS AND EQUIPMENT: See Procedure

PROCEDURE:

The following suggested activities could be planned by children:

1. Give a slide presentation of use and misuse of energy in the home and/or school.
2. Show selected movies to the school population.
3. Invite guest speakers for the school population.
4. Small groups could "manufacture" articles or art objects and record all types and uses of energy involved in the process, e.g. candles (wax, molds, wicks, coloring agents, candle holders).
5. Make a mural describing the historical progress of fuels (wood, peat, lignite, coal, oil, natural gas, nuclear).
6. Students will read their home watt-hour meter and school watt-hour meter daily for one week and graph the results.
7. Survey students and members of their families who purchase major electric appliances -- ask what influences their selection.*
8. Develop an energy conservation checklist and have each member of the school use it.

*Determine whether the amount of electricity required is considered.

Evaluation Sample
Grade 3
Unit: Energy and Conservation -- Electricity

At third grade, awareness of energy and energy conservation is the primary objective. A pre-test would provide input to determine how much awareness the student has. The same instrument can be used as a post-test. If this type of evaluation is used, the test items will be determined by the objectives of the unit.

Another method of evaluation is the application of knowledge regarding energy and energy conservation. This can be in the form of a project or verbal communication relating a general idea of what energy is and why we utilize energy conservation.

Unit Outline
Grade 3
Unit: Astronomy -- Solar
System and Galaxies

I. Earth's Revolution -- Causes of Seasons

II. Earth's Rotation -- Causes of Day and Night

III. Solar System

- A. Moon's orbit and moon phasing
- B. Sun's heat and light
- C. Planets' orbits, temperatures, and characteristics
  - 1. Gravity and inertia
  - 2. Distance from sun

IV. Stars

- A. Milky Way Galaxy and supergalaxy
- B. Star size, distance, temperature, and brightness
- C. Constellations
- D. Universe -- motion and expansion
- E. Nearest star and galaxy
  - 1. Alpha Centauri
  - 2. Andromeda Galaxy
- F. Crab Nebula

V. Space Exploration

VI. Careers in Astronomy and Space Exploration

Suggested Activities
Grade 3
Unit: Astronomy -- Solar
System and Galaxies

OBJECTIVE: To show how the earth's revolution about the sun causes our seasons

TITLE: "Earth's Revolution"

SOURCE: Charlie Brown's Second Super Book of Questions and Answers. Scholastic Book Services.

OBJECTIVE: To show how the earth's rotation gives us day and night

TITLE: "Earth's Rotation"

SOURCE: Charlie Brown's Second Super Book of Questions and Answers. Scholastic Book Services.

OBJECTIVE: To familiarize students with the nine planets that orbit the sun

TITLE: "Solar System"

SOURCE: Space, What's Out There? Coward, McCann and Geoghegan.

OBJECTIVE: To help the beginning "astronomer" begin to appreciate the stars and the immensity of the Milky Way Galaxy and other galaxies

TITLE: "Universe"

SOURCE: A Book of Stars for You. Thomas Crowell Company.

OBJECTIVE: To study the factors involved in exploration and the plans for future exploration

TITLE: "Space Exploration"

SOURCE: Space, What's Out There? Coward, McCann and Geoghegan.

OBJECTIVE: To inform the students of possible future careers in space-related fields

TITLE: "Space Careers"

SOURCE: NASA, Columbus Astronomical Society, COSI

Resources
Grade 3
Unit: Astronomy -- Solar
System and Galaxies

Text Materials

A Book of Stars for You. Thomas Crowell Company, 1967.

Charlie Brown's Second Super Book of Questions and Answers. Scholastic Book Services, 1977.

Charlie Brown's Super Book of Questions and Answers. Scholastic Book Services, 1976.

Compton's Pre-Encyclopedia: Volume 16, pp. 94-95
Volume 1, pp. 132-143
Volume 10, pp. 101-107
Volume 11, p. 58
Volume 14, pp. 148-153
Volume 3, p. 124
Volume 5, p. 40
Volume 9, p. 84
Volume 15, p. 20

Concepts in Science, Red Book, "On Earth and in Space." Harcourt, Brace, Jovanovich.

Gateways to Science. McGraw-Hill Book Company, 1979.

Learning in Science, Book 3, "The Sun, Seasons, and Climate" and "Earth Satellites." American Book Co.

Looking Into Science, Book 1, "Rockets." American Book Co.

Science, Understanding Your Environment. Silver Burdett Company, 1978.

Searching in Science, Book 2, "The Moon" and "Exploring Space." American Book Co.

Space, What's Out There? Coward, McCann and Geoghegan, Inc., 1976.

What's Up There? Scholastic Book Services, 1975.

Plan the teacher read aloud program so that you will have finished reading *Charlie and the Chocolate Factory* in time to begin reading *Charlie and the Great Glass Elevator* about two weeks after initiation of this unit, which could possibly cover a three to four week span of time.

Note: An original story written by Sue Cook, Barrington Elementary, is also available as a followup activity that could be used as the basis for a planetarium show at COSI. The students provide the narration and the art work that will be projected in the planetarium.

Films -- Grandview Heights Public Library

- Causes of Seasons
- Eagle Has Landed -- Flight of Apollo 11
- First Men Into Space
- Flaming Sky
- Solar System
- Space Science: Exploring the Moon
- Sunlight: A First Film
- Sun's Energy
- Universe
- Universe...Flight to the Stars
- Unseen World: Oceans of Space

Filmstrips -- School Library

- Constellations
- The Earth and Its Neighbors in Space
- The Earth in Motion
- Man in Space by Walt Disney
- The Moon
- Our Sky
- Our Solar System
- Revolutions -- Basic Astronomy
- Rotation
- The Sky Above Our Earth

Filmstrips (Cont.)

- The Stars
- The Sun
- The Sun and Its Family
- The Sun's Energy

Kits -- School Library

- Space, What's Out There?

Tapes -- School Library

- Traveling the Outer Space

Transparencies -- School Library

- The Earth, Sun, and Stars
- Outer Space
- The Solar System
- Stars

Exemplary Activity
Grade 3
Unit: Astronomy -- Solar
System and Galaxies

Earth's Revolution

OBJECTIVE: To show that the earth's revolution around the sun causes our seasons

MATERIALS AND EQUIPMENT: Large portable light, four globes, four students

PROCEDURE:

Station four children around a large circle facing each other. Place a large light source in the center. Each child holds a globe with axis inclined (all North Poles pointing in same direction toward an imaginary North Star).

Discuss which seasons of the year are on each globe. If children rotate the globes, they will see which ones are having longer days and shorter nights. Revolve the globes about the light, rotating them as they are moved (west to east). This will demonstrate that the two movements are occurring at the same time.

Show the film from Grandview Heights Library (following this activity) titled The Causes of Seasons.

Additional activity: Place a 100 watt lamp on a table. Leave lighted long enough to generate heat. Shade part of the light with construction paper. Note differences in heat generated in shaded and unshaded areas.

Solar System (Planet's Orbits, Temperatures, and Characteristics)

OBJECTIVE: To familiarize students with the planets in our solar system

MATERIALS AND EQUIPMENT: Solar system charts, library books, science texts and encyclopedias, planetarium from science room

PROCEDURE:

Display charts of solar system; demonstrate planetarium; make mobiles of solar system. Read "Moon, Planets, and Stars," Science Far and Near, Book 3.

Do individual research and reporting. Make game boards involving knowledge gained.

Use discs representing each planet and go to football field and have students arrange themselves in proper order around the sun (child). Divide twenty students into two teams with the captains representing the sun. See which team can get into proper places by positioning themselves in their correct order from the sun.

Solar System (Gravity and Inertia)

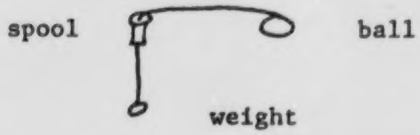
OBJECTIVE: To help students begin to understand that the forces of gravity and inertia are forces that keep the planets in their orbits

MATERIALS AND EQUIPMENT: Pail of water, whiffle ball, string (10-15 feet), empty spool, weight

PROCEDURE:

Swing a pail of water in circular motion and note what happens.

Using a whiffle ball, string (10-15 feet), and an empty spool with weight attached to the string, swing ball to demonstrate (see diagram).



Stars (Constellations)

OBJECTIVE: To help students realize that some stars make patterns in the sky called constellations

MATERIALS AND EQUIPMENT: Star charts, pictures of circumpolar constellations, black umbrella, black construction paper

PROCEDURE:

Use black construction paper and white paint to make constellations.

Taking a black umbrella, make holes to show the circumpolar constellations: Casseopia, Cephus, Draco, Ursa Major, Ursa Minor.

(Showing the film Night Sky should precede these activities.)

Plan a star party for one evening on the school playground. Invite parents and children to attend and identify stars and constellations.

Stars and Nearest Galaxies (Immensity)

OBJECTIVE: To help students attempt to realize the immensity of the universe

MATERIALS AND EQUIPMENT: One large oatmeal cookie for each student and one large field

PROCEDURE:

Each student takes an oatmeal cookie and goes to a large field. Students stand 8 feet away from each other. Explain that each cookie represents a galaxy so that they can see the immensity of the universe. Each student, once he/she is positioned, has a quiet reflective time and produces thought ramblings.

Evaluation Sample
Grade 3
Unit: Astronomy -- Solar
System and Galaxies

STUDENT SELF-EVALUATION FORM

G = tried all the time
S = tried most of the time
U = did not really try

I. Experiments and Movies

1. Did I listen and watch carefully? G S U
2. Did I try any experiments in my free time? G S U

II. Reports and Projects

1. Did I do my best and neatest work? G S U
2. Did I share my materials and the things I learned? G S U
3. Did I bring in materials from home? G S U
4. Did I listen to others' reports? G S U

List two or three activities you like the best.

1. ____

2. ____

3. ____

Name ______________________________

TEACHER EVALUATION

1. Observe conceptual understandings obtained by students.
2. Study responses to student self-evaluation.
3. Note activities that appeared to be successful.
4. Note material that did not get covered.
5. Note student enthusiasm.
    a. Did they bring in materials?
    b. Did they work on activities during free time?
    c. Did the more able students carry on extended activities that were suggested?
    d. Did the other students experience a feeling of success in completing modified activities?
6. Record suggested changes for teaching unit next year.

Unit Outline
Grade 3
Unit: Simple Machines and
Structures

I. A Machine Makes Work Easier
   A. What is a machine?
   B. How does a machine help people?
   C. Identify six (6) simple machines.

II. Lever
   A. Makes work easier
   B. Reduces force needed for lifting
   C. Fulcrum

III. Pulley
   A. Makes work easier
   B. Uses

IV. Wedge
   A. Makes work easier
   B. Wedge is two or more inclined planes put together.
   C. Force required varies with shape of wedge.

V. Wheel and Axle
   A. Makes work easier

VI. Inclined Plane
   A. Makes work easier
   B. Easier to pull or push an object up an inclined plane
   C. The longer the plane, the less force is used.

VII. Screw
   A. Makes work easier
   B. Screw is an inclined plane.
   C. A screw moves into or through an object.

OBJECTIVE: To develop an awareness of the six simple machines and how they make work easier

The teacher can introduce the unit by making a bulletin board display of "Machines." Pictures of various machines could be cut from magazines. Include simple machines such as the wheel, screw or wedge. Pictures of skates, egg beaters, bolts and screws should arouse the children's curiosity as to why these are included.

TITLE: "Machines Can Help Us"

SOURCE: Teacher developed

OBJECTIVE: To show children that simple machines are found throughout their homes

Have the children bring various machines from home including toys and small tools. Group and label items to show which of the six simple machines are involved. Some items will involve combinations of machines so that the children may have to decide under which label they would like to include the item.

TITLE: "Machines in Your Home"

SOURCE: Teacher developed

OBJECTIVE: To demonstrate that travel is made easier and faster through the use of machines

Discuss different kinds of machines that travel by making a bulletin board display of drawings of machines that travel. Cars, trucks, airplanes, bicycles, trains and rockets could be included.

TITLE: "Machines That Move"

SOURCE: Teacher developed

OBJECTIVE: To realize that a wheel and axle is a simple machine

The teacher can draw a large spoke-type wheel on butcher paper. Have the children draw and cut out various machines with wheels and paste them on the inside of the large wheel. Include items that are used at school, at home, or on the farm.

TITLE: "Wheels Help Us"

SOURCE: Teacher developed

OBJECTIVE: To become aware of simple machines found on the playground

Experiment with the playground seesaw and discover what makes the fulcrum. Discover how one child is the weight and the other the force and how their work is exchanged as they alternate going up and down.

TITLE: "A Seesaw Is a Machine"

SOURCE: Teacher developed

OBJECTIVE: To record data relating to the six simple machines

After each type of simple machine has been introduced, write a group story. Have the children copy the stories and make illustrations to go with each story. Put these together and make a booklet on "Machines."

TITLE: "What Have We Learned About Machines?"

SOURCE: Teacher developed

OBJECTIVE: To let children demonstrate how a simple machine can be used to lift a heavy object

Use a board 4 feet in length and a block of wood. Have some students lift various objects with the board and the block, changing the position of the block. If the board is strong enough, a student may be able to lift the teacher.

TITLE: "Can You Lift the Teacher?"

SOURCE: Teacher developed

Resources
Grade 3
Unit: Simple Machines
and Structures

Text Materials

Elting, Mary. Machines at Work. Harvey House, 1962.

Gateways to Science. McGraw-Hill, 1979.

Mobiles. ESS Teacher's Guide and kit.

Pine, Tillie S., and Levine, Joseph. Simple Machines and How We Use Them. McGraw-Hill, 1965.

Saunders, F. Wenderoth. Machines For You. Little Brown and Co., 1967.

Schultz, C. Charlie Brown's Super Book of Questions and Answers. Scholastic Book Services, 1976.

Science Far and Near, Teacher's Edition. Heath.

Science Is Exploring, Teacher's Edition. Scott Foresman.

Sharp, Elizabeth N. Simple Machines and How They Work. Random House, 1959.

Zim, Herbert S., and Skelly, James R. Hoists, Cranes, and Derricks. Wm. Morrow and Co., 1969.

Films -- Grandview Heights Public Library

Action and Reaction, 13 min.

Attraction of Gravity, 9 min.

Filmstrips -- school library or IRC

Whys of Elementary Science
"How Levers Help Us"
"How Ramps and Screws Help Us"
"How Wedges Help Us"
"How Wheels Help Us"

Transparencies

Transparency books relating to simple machines are available in every building's science storage room.

Kits

Structures. Related ESS teacher's guide and kit that may be incorporated into the unit. Available for third grade teachers in every building. This is a "hands-on" unit in which students build intriguing structures such as houses, towers, and airplanes out of materials like straws, clay, and pins.

Pulleys, spring scales, and simple machine kits from science room

Exemplary Activity
Grade 3
Unit: Simple Machines and
Structures

OBJECTIVE: To make children aware of the many types of simple machines that are found in our daily lives

MATERIALS AND EQUIPMENT: Old magazines brought from home, such as Sports Illustrated

PROCEDURE:

Instruct children to find examples of each of the six kinds of simple machines. Cut out, mount, and label them. The pictures may be assembled into a booklet, with a table of contents and several pages for each machine. Or, only one large sheet of manila drawing paper may be used and the pictures mounted and labeled on this page.

Evaluation Sample
Grade 3
Unit: Simple Machines and
Structures

Locate a large poster that has many types of simple machines included in the content.

Directions:

1. Make 6 columns on your paper.
2. Put the name of a simple machine at the head of each column.
3. List (under the proper heading) all the simple machines you can find in the picture.

Unit Outline
Grade 3
Unit: Animals and Animal Tracks

Introduction to Animals and Animal Tracks: For the child, there is much reward in unraveling the events that shaped a track -- the animal that made it, the direction it was going, whether it was moving quickly or slowly, how long ago it lived, and many other fascinating discoveries.

I. Introduction to Animals and Animal Tracks

  A. Relate individual track models to an animal family.
  B. Discuss what a track can indicate about its owner's size, weight, etc.
  C. Categorize models according to determined sets.
  D. Match track models to animal pictures.
  E. Look for animal tracks in soft terrain.

II. Track Patterns

  A. Interpret tracks made by one or more animals -- note speed, activity, length of legs, weight, changes in direction or speed, use of feet, etc.
  B. Determine the number of animals present at a site.
  C. Suggest a story that track patterns might tell or an activity that track patterns might reveal.

III. Prints and Casts of Tracks

  A. Use ink, tempera, plaster, etc. to duplicate track models.
  B. Make plaster casts from tracks found outdoors.
  C. Use pets to make track patterns.
  D. Set a track trap and record tracks if and when animals are attracted and leave impressions.

IV. Tracks Made by Humans

  A. Make individual and class composite of fingerprints.
  B. Make individual and class collage of footprints.
  C. Observe and record types of tracks made by someone's machine, e.g. car, truck, tractor.

Suggested Activities
Grade 3
Unit: Animals and Animal Tracks

OBJECTIVE: To observe and become familiar with animal tracks

TITLE: "What Are Tracks About?"

SOURCE: ESS Tracks
ESS teacher's guide for Tracks (pp. 20-43)
ESS Track Cards
ESS Track Models

OBJECTIVE: To determine characteristics of animals and circumstances involved in a track record or pattern

TITLE: "What Happened Here?"

SOURCE: ESS teacher's guide for Tracks (pp. 16-19)

OBJECTIVE: To observe and record tracks made by animals in classroom and out of doors

TITLE: "Footprint Casting and Printing"

SOURCE: ESS Track Models
ESS teacher's guide for Tracks (pp. 10-15)

OBJECTIVE: To observe differences and similarities in fingerprints

TITLE: "Finger Printing"

SOURCE: ESS teacher's guide for Tracks (pp. 14-15)

OBJECTIVE: To become more aware of animal behavior by locating and interpreting various animal tracks

TITLE: "Big Tracks, Little Tracks, All Kinds of Tracks"

SOURCE: Teacher developed activity to take place at the Upper Arlington Schools' Land Laboratory

Refer to Elementary Science Study (ESS) teacher's guide and all necessary materials available in every elementary building.

Resources
Grade 3
Unit: Animals and Animal Tracks

Text Materials/Library Sources

Branley, F. Big Tracks, Little Tracks. Scholastic Book Services, 1960.

Gateways to Science. McGraw-Hill, 1979.

Mason, G.F. Animal Tracks.

Murie, O.J. A Field Guide to Animal Tracks.

Schultz, C. Charlie Brown's Super Book of Questions and Answers. Scholastic Book Services, 1976.

Science, Understanding Your Environment. Silver Burdett, 1978.

Selsam, M. Benny's Animals.

_________. How to Be a Nature Detective. Harper Row, 1966.

Tracks, ESS Teacher's Guide

Track Picture Book, ESS.

Kits and Materials

ESS Mystery Track Cards and Animal Track Cards

Two materials kits that contain rubber animal track molds and models, plaster of paris, and ink pads

Outdoor Biology Instructional Strategies (OBIS) -- Sets I, II, III, and IV

Land Lab

Exemplary Activity
Grade 3
Unit: Animals and Animal
Tracks

OBJECTIVE: To observe and record tracks made by animals in the classroom and out of doors

MATERIALS AND EQUIPMENT: ESS Track Models, plaster, ink pads, tempera paint, live pets, track trap area, lengths of newsprint, large pieces of construction paper (Also see materials listed in ESS teacher's guide for Tracks, p. 4.)

PROCEDURE:

1. Model printing and casting
   a. Children can make plaster casts and ink prints from ESS Track Models.
   b. After viewing and discussing track cards and materials, students can make their own track prints from potatoes, clay, etc. Using large pieces of construction paper, the students will independently begin to make tracks stories as they print. (See ESS teacher's guide for Tracks, p. 4.)
2. Finding and making casts out of doors
   a. See ESS teacher's guide for Tracks, pp. 5-8.
3. Tracking live animals
   a. Children may cooperatively write a class letter to their parents to explain their unit of study and project, and to seek willing parents who will bring a cooperative pet to the classroom and take it home after its tracks have been printed.
   b. Work out a schedule with no more than one pet at a time in the classroom. A second adult assisting in the classroom can be helpful.
   c. In advance, tape a length of paper to the floor. The length should be proportional to the animal's size to permit the animal to move and make a track pattern.
   d. Brush tempera on all of the animal's feet.
   e. Have the children sit quietly at the sides of the paper to keep the moving animal on a course on the surface of the paper.
   f. Have sponges, water, and towels to clean the animal's feet.
   g. Labeling may include the animal's name, arrows to show the animal's movement and direction, words to describe activity, etc.
   h. After prints are dry, discuss what the tracks communicate.

Evaluation Sample
Grade 3
Unit: Animals and Animal
Tracks

A. Observe individual involvement, responses, etc., with hands-on and discussion experiences.

B. Provide track patterns for creative thinking and writing. Note insights and use of tracking concepts indicated during individual responses.

Unit Outline
Grade 3
Unit: Drops, Streams, and
Containers

Introduction to Drops, Streams, and Containers: This unit invites young children to explore, in a leisurely informal manner, the behavior of water and other common liquids. Suggestions are given to encourage students to pursue those facets that interest them most, with a minimum of direct teacher intervention. Teacher's guides and kit materials for this unit are available in every elementary building.

I. Properties of Drops

  A. Surface tension of water
  B. Breaking up surface tension
  C. Adhesion to other materials (capillary action)

II. Buoyant Force

  A. Weight of various liquids
  B. Weight of objects in water
  C. Salt water
  D. Hydrometer

III. Changes in State

  A. Evaporation
    1. Factors affecting rate
  B. Substances left behind when state changes
  C. Space occupied by the three states
  D. Water cycle
    1. Cloud formation
    2. Weather

IV. Substances dissolve in water

  A. Filters
  B. Conservation

V. Pressure

  A. Depth affects pressure

Suggested Activities
Grade 3
Unit: Drops, Streams, and
Containers

OBJECTIVE: To identify and describe the properties (e.g., size, shape, etc.) of drops

TITLE: "Drip, Drop"

SOURCE: Teacher developed from the Elementary Science Study Unit titled "Drops, Streams, and Containers."

OBJECTIVE: To demonstrate surface tension and how it can be broken

TITLE: "Break It Up"

SOURCE: Freeman, Mae and Ira. Fun With Science. New York: Scholastic Book Service, 1968, pp. 26-28.

OBJECTIVE: To investigate the cohesive and adhesive properties of water

TITLE: "Climbing Up and Down"

SOURCE: Schmidt, Victor E. and Rockcastle, Verne N. Teaching Science With Everyday Things. New York: McGraw-Hill Book Company, 1968.

OBJECTIVE: To compare the weights of various liquids and predict weight relationships between objects not compared (e.g., object A is heavier than B by 2 units and heavier than D by 4 units; therefore, B is heavier than D by 2 units)

TITLE: "Weighing a Liquid"

SOURCE: Sink or Float, ESS Unit, in the science storage room located in each elementary building

OBJECTIVE: To show the upward force or buoyancy of water

TITLE: "Let's Lose Some Weight"

SOURCE: Resource file of experiments located in every building's science room

OBJECTIVE: To show the relationship between the concentration of salt in water and the buoyancy of objects

TITLE: "It's Salty"

SOURCE: Resource file of experiments in the school science room. Also found in Freeman, Mae and Ira. Fun With Science. New York: Scholastic Book Services, 1968.

OBJECTIVE: To make a float that shows the density of a liquid

TITLE: "The Hydrometer"

SOURCE: Schmidt, Victor E. and Rockcastle, Verne N. Teaching Science With Everyday Things. New York: McGraw-Hill Book Company, 1968, p. 31.

OBJECTIVE: To show that water evaporates into the air and that the rate of evaporation depends upon certain factors

TITLE: "Where Did It Go?"

SOURCE: Partly in Jacobson, Willard J., Lauby, Cecilia J., Konicek, Richard D. Learning in Science. Cincinnati: American Book Co., 1965, pp. 52-64.

OBJECTIVE: To investigate the fluctuating space requirements of a given amount of liquid as it changes from one state to another

TITLE: "The Vapor Push and the Ice Surge"

SOURCE: Schmidt, Victor E. and Rockcastle, Verne N. Teaching Science With Everyday Things. New York: McGraw-Hill Book Company, 1968, p. 33.

OBJECTIVE: To make a laboratory cloud

TITLE: "I Want It Back"

SOURCE: Concepts in Science. New York: Harcourt, Brace, Jovanovich, Inc., 1972, p. 93.

OBJECTIVE: To discover that water, when it evaporates, leaves behind many impurities

TITLE: "Left Behind"

SOURCE: Teacher developed

OBJECTIVE: To discover that sugar and salt dissolve in water, but other substances (starch, flour, and sand) do not; to show which substances, when "mixed" with water, will slip by a filter

TITLE: "I'll Slip By"

SOURCE: Resource file of science experiments found in the building science room

OBJECTIVE: To discover that the deeper the water, the greater its pressure

TITLE: "The Pressure's On"

SOURCE: Resource file in the science room. Also, Freeman, Mae and Ira. Fun With Science. New York: Scholastic Book Services, 1968, pp. 20-21.

Resources
Grade 3
Unit: Drops, Streams, and Containers

Text Materials

Brandwein, Paul F.; Cooper, Elizabeth K.; Blackwood, Paul E.; Hone, Elizabeth B.; Fraser, Thomas P. Concepts in Science. New York: Harcourt Brace Jovanovich, Inc., 1972, pp. 93-101.

Drops, Streams, and Containers. ESS Teacher's Guide and Activity Cards.

Gateways to Science. McGraw-Hill, 1979.

Jacobson, Willard J.; Lamby, Cecilia J.; Konicek, Richard D. Learning in Science. Cincinnati: American Book Company, 1965, pp. 52-64.

Schultz, C. Charlie Brown's Super Book of Questions and Answers. Scholastic Book Services, 1976.

Science: Understanding Your Environment. Silver Burdett, 1978.

Films -- Grandview Heights Public Library

Challenge of the Oceans

Clouds Above

Density

Ice

The Making of a River

Surface Tension

Filmstrips

Clouds, Rain, Snow. 49H School Library

Our Weather. 48G School Library

Understanding Weather and Climate. SVE Educational Filmstrips with cassettes

What Makes It Rain? 24D School Library

Transparencies

Oceanography. Found in the science room of each elementary building.

Weather. Found in the science room of each elementary building.

Kits

ESS materials kit for Drops, Streams, and Containers

Elementary Science Study Units That Can Be Correlated to Unit

Clay Boats. Children investigate possibility of making a lump of clay float in a container of water. They experiment with different shapes of clay and when they discover a shape that floats, they test to see how much "cargo" their boats will hold. This is a first grade science unit that can be reviewed and advanced in grade three.

Sink or Float. Children work with many objects that either sink or float in tap water, salt water, and cooking oil, learning about buoyancy and displacement of columns of liquid. Teacher's guide and kit available from science consultant.

Exemplary Activity
Grade 3
Unit: Drops, Streams, and
Containers

OBJECTIVE: To investigate the cohesive and adhesive properties of water

MATERIALS AND EQUIPMENT: Sturdy books or building blocks, rulers, scissors, pencil, paper, strips of cloth, paper toweling, corrugated paper, red dye, rubbing alcohol, salad oil, water, paper cups, tape, small pails

PROCEDURE:

Divide the class into groups of four.

Let each pupil in a group cut three 10-inch strips from one of four different materials, such as cloth, paper toweling, newspaper, corrugated paper.

Rest a ruler across two books or wood blocks and tape one end of each strip of different material to the ruler.

Let each student fill a paper cup with colored water.

At a signal, let them place their cups under their strips of material and observe how the water climbs. In which strip does the water rise the fastest? In which has it risen the farthest after five minutes? Take the strips out of the water and measure with a ruler the distance the water has climbed. Record the findings on a simple chart.

Material	Distance
1. Cloth	
2. Newspaper	
3. Toweling	
4. Corrugated paper	

Do the experiment again with a different liquid. Let some groups experiment with cooking oil and some with alcohol. Do these liquids climb the way water does?

Now let each group compare the rate at which water moves both up and down certain materials. Fill a small plastic container with red water and elevate it on a block of wood. Place four empty paper cups around the elevated container. Make a point on one end of the four remaining strips of material. Put each strip of material into the full bucket and let it hang over the side and down into the empty cup. Through which strip does the water soak to the point? Does the water stop moving when it comes to the point? What happens to the empty cup?

Followup:
1. Change the information in the table to bar graph form.
2. Let each child put celery or flowers into colored water. Watch the water "climb" the stem.
3. Let each child make a picture showing a plant, rain, and, by means of arrows, the direction water moves in a plant.

Evaluation Sample
Grade 3
Unit: Drops, Streams, and
Containers

1. List 8 facts that you have learned about water in this unit.

2. Multiple choice: Choose the one best answer and record it on the blank at the left.

____ 1. Drops of water remain suspended on tree branches because of the (a) buoyancy (b) surface tension (c) weight of water.

____ 2. Objects float more easily in water that has (a) salt (b) flour (c) sand in it.

____ 3. The instrument that measures the amount of antifreeze in a car is a (a) thermometer (b) speedometer (c) hydrometer.

____ 4. When water turns to a gas, it is said to have (a) condensed (b) evaporated (c) frozen.

____ 5. A sand filter can remove (a) salt, (b) twigs, (c) sugar from water.

3. Matching

____ Conservation	1.	The force or weight of water
____ Buoyant	2.	To disappear in a liquid
____ Surface tension	3.	Able to float
____ Dissolve	4.	To save and protect the natural resources
____ Hydrometer	5.	H_2O
____ Condensation	6.	To remove impurities from water
____ Evaporation	7.	The change of a liquid into a gas
____ Filter	8.	A floating instrument used to measure the density of a liquid
____ Water pressure	9.	The change of a gas into a liquid
____ Water	10.	The sticking together of water parts like a skin

Unit Outline
Grade 3
Unit: Mirror Cards

Introduction to Mirror Cards: A hands-on series of group activities that give children an opportunity to experiment with some concepts of geometric optics and symmetry. Children attempt to match, by means of a mirror, a pattern on one card with a pattern shown on another. Provides a good basis for understanding more formal geometric concepts later. A teacher's guide and kit are available to third grade teachers in every building.

I. Mirror Cards: Light

   A. Symmetry -- visual balance
   B. Reflection

II. Skills

   A. Observation -- attempt to replicate a pattern with the mirror
   B. Classification -- based upon observable characteristics
   C. Measurement -- comparing size, shape, and arrangement of patterns relative to the line of symmetry
   D. Prediction -- which patterns can and cannot be made using a mirror

OBJECTIVE: The student will predict whether or not a mirror will change the observed pattern.

TITLE: "House Set"

SOURCE: ESS teacher's manual Mirror Cards

OBJECTIVE: The student will describe orally the difference between congruent and noncongruent patterns.

TITLE: "Heart Set"

SOURCE: ESS teacher's manual Mirror Cards

OBJECTIVE: The student will identify which patterns will change after reflection.

TITLE: "Dot Set"

SOURCE: ESS teacher's manual Mirror Cards

OBJECTIVE: The teacher gives each child a small handful of confetti made from colored construction paper. The student uses two mirrors hinged together with tape to create such things as flowers, people, and animals.

TITLE: "A Mess of Confetti"

SOURCE: Teacher

OBJECTIVE: The teacher draws such things as a circle, triangle, and a straight line on the chalkboard. Each student draws this on a sheet of white paper and follows the teacher's instructions to use two hinged mirrors to create nine circles, seven triangles, or whatever.

TITLE: "Draw What I Draw"

SOURCE: Teacher

Resources
Grade 3
Unit: Mirror Cards

Text Materials

Feravolo, Rocco V. Junior Science Book of Light.

Freeman, Mae and Ira. Fun and Experiments with Light.

Gateways to Science. McGraw-Hill, 1979.

Mirror Cards. ESS teacher's guide.

Rogers, Frances. Lens Magic.

Schultz, C. Charlie Brown's Second Super Book of Questions and Answers. Scholastic Book Services, 1978.

Schultz, C. Charlie Brown's Super Book of Questions and Answers. Scholastic Book Services, 1977.

Science: Understanding Your Environment. Silver Burdett, 1978.

Films -- Grandview Heights Public Library

Learning About Light Reflection

Transparencies

Heat, Light, and Sound -- School library or IRC

Kits and Materials

ESS materials kit for Mirror Cards

Activity cards for Mirror Cards

Prisms and mirrors

Exemplary Activity
Grade 3
Unit: Mirror Cards

OBJECTIVE: These activities bring home to the children the realization that when the mirror slides along the line made by its edge on the card, the image does not slide with it.

MATERIALS AND EQUIPMENT: Mirror, mirror cards set 8-21, ESS teacher's guide Mirror Cards

PROCEDURE:

Give each child a mirror and a set of mirror cards. The children are asked, "By placing the mirror on the mirror card, which of the patterns on the other cards can you match?"

Evaluation Sample
Grade 3
Unit: Mirror Cards

The best type of evaluation for this type of activity is for the children to demonstrate the principles they have learned with the mirror cards. Oral questioning from the teacher should accompany this to make sure the child has understood the concepts.

Unit Outline
Grade 4
Prehistoric Life

I. Organization of Information
   - A. Time chart
   - B. Four eras

II. Precambrian Era
   - A. Major plants -- algae
   - B. Major animals -- protozoa

III. Paleozoic Era
   - A. Major plants
     - 1. Mosses
     - 2. Ferns
     - 3. Horsetails
   - B. Formation of coal beds
   - C. Major animals
     - 1. Trilobite
     - 2. Brachiopod
     - 3. Vertebrates
       - a. Fish
       - b. Amphibians
     - 4. Insects

IV. Mesozoic Era
   - A. Major plants -- cycad
   - B. Major animals
     - 1. Reptiles
       - a. Dinosaurs
       - b. Flying reptiles
     - 2. Early birds

V. Cenozoic Era
   - A. Major plants
     - 1. Hardwood trees
     - 2. Grasses
   - B. Major animals
     - 1. Mammals
     - 2. Man

Suggested Activities
Grade 4
Unit: Prehistoric Life

OBJECTIVE: To reinforce the concept of how fossils are formed

TITLE: "Making Fossil Prints"

SOURCE: Probing Into Science. American Book Co., 1965, p. 63.

OBJECTIVE: To focus attention on the various features of the dinosaurs and their likenesses and differences

TITLE: "Clay Dinosaurs"

SOURCE: Teacher developed

OBJECTIVE: To make children aware of the various types of fossils found in the area. Have children bring in fossils to make a class display. Identify the fossils and estimate their age.

TITLE: "Where Did All Those Fossils Come From?"

SOURCE: Teacher developed

OBJECTIVE: To introduce or reinforce the concept of microscopic life found in water. Contact the science consultant for protozoa-growing kit, microscopes, and a micro-projector.

TITLE: "Little Bugs in the Water"

SOURCE: Science consultant

Resources
Grade 4
Unit: Prehistoric Life

Text Materials

Jacobson, Lauby, Konicek. Probing Into Science. American Book Co., 1965, pp. 49-96.

Prehistoric Life. The Warwick Press, 1974.

The Prehistoric World. The Warwick Press, 1975.

Science Book of Volcanoes. Scholastic Book Services, 1969.

Science, Understanding Your Environment. Silver Burdett, 1978.

Films -- Grandview Heights Public Library

Dinosaur Age

Journey Into Time

Prehistoric Times

Filmstrips -- School Library

Dinosaurs. Educational Dimensions.

Life Long Ago. Society for Visual Education.

Transparencies -- School Science Room

Life of the Past. Milliken Publishing Co.

Prehistoric Life. Milliken Publishing Co.

Study Print

Dinosaurs and Other Prehistoric Creatures. School library.

Materials

Microprojector from science room
Fossils
Magnifying lenses

Exemplary Activity
Grade 4
Unit: Prehistoric Life

OBJECTIVE: To become familiar with different types of fossils and how the organisms would have appeared millions of years ago

MATERIALS AND EQUIPMENT: 1 small ridged shell or similar object, 1 1/2 pint milk carton, Vaseline, plaster of Paris, marbles, modeling clay, small cardboard box

PROCEDURE:

1. Cut off top of milk carton. Cover shell with thick coating of Vaseline. Put shell in the carton bottom, ridged side up. Mix plaster of Paris to make a soft paste. Pour mixture over shell, covering it completely. When plaster is hardened, tear off carton and remove shell.

2. Make a fossil nest of dinosaur eggs by putting a thick layer of modeling clay in the bottom of a small cardboard box. Press 9 or 10 marbles into the clay close together and then remove the marbles very carefully. Mix one cup of plaster of Paris with water to make a soft paste. Pour the plaster into the box and let it harden. Remove the plaster from the box and turn it over. You have made a cluster of "dinosaur eggs" for your class display.

Evaluation Sample
Grade 4
Unit: Prehistoric Life

Science Test -- Prehistoric Life

Name ______________________ Date ______________

I. Fill in the missing word; each word is only used once!

invertebrate
dinosaur
Cenozoic
amphibian
Pre-cambrian
fossils
prehistoric
cold-blooded
carbon
vertebrate
Paleozoic
conifers
era
paleontology
protozoa
warm-blooded

1. A division of time is called an ______________________.
2. An animal with a backbone is called a ______________________.
3. During what era was the Coal Age? ______________________
4. When an animal's body temperature changes with the outside temperature, it is ______________________.
5. The word that means "before written records" is ______________________.
6. The study of fossils is called ______________________.
7. This animal is a prehistoric reptile. ______________________
8. We live in what era? ______________________
9. An animal without a backbone is called an ______________________.
10. The basis for coal is ______________________.
11. An animal that lives both in the water and on land is an __________.
12. The traces of plants or animals found in rocks are ______________.
13. One-celled animals are called ______________________.
14. Animals whose bodies always stay about the same temperature are ______________________.
15. Cone-bearing trees are called ______________________.
16. One-celled animals lived in this era. ______________________

II. Name four characteristics of a mammal:

1. ______________________ 2. ______________________

3. ______________________ 4. ______________________

III. Match these words by putting the correct number on the blanks.

1. cycad ____ body of three parts
2. dinosaur ____ changes in form or structure
3. metamorphosis ____ man
4. trilobite ____ palm tree
5. mammal ____ terrible lizard

Unit Outline
Grade 4
Unit: Geology -- Rocks and Minerals

Description of Unit: In planning a unit concerning the earth and its history, the teacher will help to develop further the natural curiosity of the students in understanding more about our own planet. As man studies space today, he is discovering new and interesting facts. The science of geology is also a discipline that holds its own mysteries and theories. Its study broadens the students' horizons and helps to familiarize the students as to the past and present knowledge discovered concerning our ever changing earth.

The objectives of a geology unit may be divided into several sections. The first section of the unit deals with acquainting the students with the formation of the earth, as well as the theories on how it was formed and the reasons for some of these beliefs. By studying the evolution of the earth's landscape and the forces working to change its appearance, the children will develop a greater scientific background of the methods and problems peculiar to geology and how geologists go about their work.

The second section of this unit is concerned with the rocks, minerals, and crystals found in the earth. The ESS teacher's guide and kit, Rocks and Charts, will provide many hands-on experiences for the children in this phase of the unit. Through this aspect of a geology unit, the students will study theories on how rocks, minerals, and crystals were formed, and will acquire some knowledge of the uses man makes of them. If the teacher feels reluctant to let the children become involved in this area of science because there are so many facts to learn, do not hesitate. Begin with your children. You can learn as you help them to learn. Scientific knowledge grows at an amazing rate in a classroom when the children realize the teacher is a learner, too.

I. How the Earth Was Formed

A. Hypotheses are scientific suggestions based on facts and used to find new facts.
B. Several hypotheses have been made to explain how the earth was formed.
C. Scientists believe that the earth may have been very hot when it was forming and that the earth changed as it cooled.
D. The earth is somewhat like a sphere, but flattened at the poles.
E. The earth is made up of the crust, mantle, and the core.
F. Geologists study layers of rock and radioactive rocks to estimate the age of the earth.
G. The history of the earth has been divided according to certain characteristics and events into eras.
H. Volcanoes, earthquakes, and glaciers caused great changes on the surface of the earth.
I. The cooling of the earth could have caused the earth to change because the outer part of the liquid mass cooled more quickly than the inner part. Such a cooling caused a crust to form around the earth, while the inner part remained in a molten state.

J. The wrinkles and folds in the surface of the earth could have been formed by the fact that the material beneath the crust cooled and therefore contracted. This action may have caused parts of the earth to begin cracking. Wrinkles and folds were created.
K. The Ice Age was the time when much of the earth was covered by sheets of ice. The great ice sheets advanced and receded at least four times.
L. Erosion and weathering change the earth's surface.
M. Forces within the earth raise and lower its surface.

II. Rocks, Minerals, and Crystals

A. Rocks were formed by forces that have been at work for a long period of time. These forces are still at work.
B. Rocks help tell about life on the earth at an earlier date in time.
C. Rocks contain minerals. Some rocks contain only a few minerals, while other rocks contain several minerals.
D. We use rocks and minerals in many ways.
E. There are many kinds of minerals. Minerals are formed inside the earth.
F. Most minerals are made up of crystals. Crystals are of different sizes and different shapes. Each kind of mineral has a crystal shape of its own.
G. Rocks are grouped according to how they were formed; the three groups are igneous, sedimentary, and metamorphic rocks.
H. Igneous rocks are formed from hot liquid magma that seeps from cracks within the earth.
I. Sedimentary rocks are formed from the eroded rock materials that are carried to bodies of water and settle to the bottom in layers.
J. Metamorphic rocks are of igneous and sedimentary origin, having been changed by great heat and pressure.
K. Minerals we eat: for example, iron and calcium. Minerals in food were part of the food that the plants and animals that we eat used.
L. Minerals we wear: for example, gold, copper, silver, gems -- crystals of quartz, rubies, garnets, and diamonds -- are worn as jewelry.
M. Intelligent use of our mineral resources such as coal, iron, oil, and natural gas is important to us today and in the future.

Suggested Activities
Grade 4
Unit: Geology -- Rocks and Minerals

OBJECTIVE: To stimulate interest in the study of geology

TITLE: "Introduction to the Geology Unit"

SOURCE: Teacher developed. The teacher can set up an exhibition of various rocks and minerals with books of varying reading levels surrounding this display. Let the children freely examine this display and browse through the books. This generally stimulates children to bring in their own rock collections that they can set up and share with the class.

OBJECTIVE: To teach children how to make crystals and let them grow their own crystals using salt, sugar, urea

TITLE: "Growing Crystals"

SOURCE: Probing Into Science, 4. American Book Co., p. 43.

OBJECTIVE: To demonstrate the formation of rock layers. Children will need a large glass jar, water, sand, and several types of soil.

TITLE: "Sedimentary Rocks Are Formed in Layers"

SOURCE: Probing Into Science, 4. American Book Co., p. 27.

OBJECTIVE: To determine the scale of hardness of a rock or mineral. Children can do this by using their fingernail, a copper coin, a knife, and a piece of glass.

TITLE: "Rocks Are Hard"

SOURCE: Probing Into Science, 4. American Book Co., p. 42.

OBJECTIVE: To gain greater understanding of geology concepts by constructing murals. The class can make murals depicting almost any phase or phases of this unit. Examples: (a) hypotheses on how the earth began (b) the work of glaciers, volcanoes, and earthquakes (c) demonstrating how sedimentary, igneous, and metamorphic rocks are formed (d) using our minerals wisely

TITLE: "Constructing Murals"

SOURCE: Teacher developed

OBJECTIVE: To understand how volcanoes are formed and caused to erupt. The science consultant will supply the necessary chemicals.

TITLE: "The Exploding Volcano"

SOURCE: Science consultant

Resources
Grade 4
Unit: Geology — Rocks and Minerals

Text Materials

Concepts and Challenges in Earth Science, Book 1. Cebco Standard Publishing Co., 1974.

Discovering With Science, Book 4. Ginn.

Exploring Science, Green Book. Laidlaw Brothers, 1979.

How and Why Wonder Book of Rocks and Minerals. Grosset and Dunlap.

Probing Into Science, Book 4. American Book Co.

Rocks and Charts, ESS Teacher's Guide. McGraw-Hill.

Rocks and Minerals. Follett Publishing Company, 1962.

Science Book of Volcanoes. Scholastic Book Services, 1969.

Science, Understanding Your Environment. Silver Burdett, 1978.

Zim, Herbert, and Shaffer, Paul. Rocks and Minerals. Golden Nature Guides.

Films -- Grandview Heights Public Library

Earthquakes and Volcanoes, 14 min., 1957

Eternal Change: Story of a Mountain, 14 min., 1974

Face of the Earth, 12 min., 1954

Rocks and Minerals, 10 min., 1955

Filmstrips

Various filmstrips relating to geology are available from the school library and IRC.

Transparencies

Rocks and Minerals. Geology. Milliken transparency books. Available from school science room.

Kits and Materials

ESS materials kit for Rocks and Charts; rock charts and rock kits

Exemplary Activity
Grade 4
Unit: Geology -- Rocks and Minerals

OBJECTIVE: To gain understanding of the geologic formation of volcanoes and to observe the chemical eruption of a volcano

MATERIALS AND EQUIPMENT: A volcano constructed by class members, small jar, newspapers, ammonium dichromate, and strips of magnesium

PROCEDURE:

The study of volcanoes is a very interesting phase of the unit on geology. As a class project, one or more of the students can construct a model of a volcano by using paper mache or clay. The cone of the volcano must be large enough to insert a small glass jar. The science consultant will prepare a mixture of ammonium dichromate and small pieces of magnesium ribbon. Newspapers should be placed under and around the volcano. Pull the shades, turn off the lights, and light the fuse. The chemical eruption is a spectacular simulation of an exploding volcano as orange flames and green powder hiss from the volcano's cone. The exploding volcano demonstration will stimulate interest in class discussion and reports.

Evaluation Sample
Grade 4
Unit: Geology -- Rocks and
Minerals

If the teacher has used various science texts for reading and discussion with the class; has helped the children to utilize other reading materials for further sources of information; and has exposed the class to visual aids, experiments, study sheets, research projects, field trips, and guest speakers, the unit has been an in-depth study.

Time is then spent in reviewing these units and teaching the children study skills. The final action taken to check the children's general knowledge of the intended concepts is to give a comprehensive test. A sample of this test follows. At least eighty percent (80%) of the class should demonstrate highly satisfactory results of what they have learned. If a child does poorly, give the child the test again, but allow the child to use books in order to find the answers he or she missed.

SCIENCE TEST

Name ______________________________ Date ______________

Are you ready? We've been reading together from several books and we've had many discussions of the material presented. You've been on a field trip; had a guest speaker; experimented; seen filmstrips, slides, and many movies to help you understand this last science unit. You were given almost two weeks to study for this test. Good luck and go to it!

I. Choose from the following list to fill in the blanks.

1. Mound Builders
2. volcano
3. uranium
4. prehistoric
5. Cenozoic Era
6. earthquake
7. geologist
8. glacier
9. carbon
10. fault
11. lava
12. magma
13. mineral
14. igneous rock
15. moraine
16. metamorphic rock
17. seismograph
18. sedimentary rock
19. mountain
20. archaeologist

1. ______________ A chemical element found in coal and petroleum, and in plant and animal bodies
2. ______________ An instrument for recording vibrations in the earth
3. ______________ Rock changed by great heat and pressure
4. ______________ Concerning the period before any events were recorded in writing
5. ______________ A huge sheet of ice that moves slowly down a slope or over a wide area of land
6. ______________ Prehistoric Indians

Evaluation Sample (Cont.)
Grade 4
Unit: Geology -- Rocks and Minerals

7. ________________ A person skilled in the study of the history of the earth and its life
8. ________________ A natural substance, such as iron or gold, that is neither plant nor animal
9. ________________ A liquid rock material within the earth from which an igneous rock results by cooling
10. ________________ A mountain formed when melted rock, steam, and ashes are forced through a hole in the earth's surface
11. ________________ A split in the earth's crust in which layers of rock slip past each other
12. ________________ A rock formed by the hardening of hot liquid materials
13. ________________ The most recent of the four major eras of the earth's history that extends to the present time
14. ________________ Melted rock that has been thrown from a volcano or that has cooled and hardened
15. ________________ Scientists who study early cultures
16. ________________ An upward projection of masses of rock that rise high above the land around them
17. ________________ Rock formed in layers under water from deposits of sand, mud, soil, and pebbles
18. ________________ A silvery-white metal that gives off energy
19. ________________ A shaking or trembling of part of the earth, caused by the slipping of large masses of rock past each other suddenly
20. ________________ A load of rocks and soil deposited by a melting glacier

II. Draw a line through the word or words that do not fit the sentence. Please use a marking pen to do so.

1. The Mound Builders probably built mounds for protection from enemies, worship of spirits, places to keep their written records, and burial of their dead.

2. Serpent Mound or "oppossum" mound appears to be holding an egg in its mouth.

3. Sandstone, conglomerate, and pumice are examples of sedimentary rocks.

4. The koala bear, kangaroo, horse, and the platypus are examples of animals referred to as deviates.

5. Granite, marble, obsidian, and lava are examples of igneous rocks.

6. Crystals of quartz, rubies, garnets, sulphur, and diamonds are considered to be precious gems.

7. Marble, limestone, gneiss, and slate are examples of metamorphic rocks.

8. Below the surface of the earth can be found buried treasures such as gold, silver, salt, sugar, coal, and copper.

9. Some of the forces that change the appearance of our earth are wind, water, glaciers, seismographs, and volcanoes.

10. Glaciers form U-shaped and V-shaped valleys.

III. True or False. Do not abbreviate these words.

1. ____________ You can scratch the mineral talc with your fingernail.

2. ____________ Some of the ways rocks differ are their color, the minerals they contain, how they are formed, their weight, and the way they feel.

3. ____________ When you sit down to eat your supper, lunch, or breakfast, you eat some kinds of foods that contain minerals.

4. ____________ Scientists know the exact time when man first appeared on earth.

5. ____________ Over a very long period of time, uranium slowly changes to lead and, by studying how much change has taken place in a rock, scientists can determine the age of the rock.

6. ____________ By examining a rock containing lead and uranium, scientists use a seismograph to tell how long ago the uranium began to change to lead.

7. ____________ The first people to live in the Ohio Country were the explorers and the missionaries.

8. ____________ The Hawaiian Islands are of volcanic origin.

9. ____________ The surface of the earth is much the same as it looked millions of years ago.

10. ____________ The Hopewell people and the Adena group were two large groups of Mound Builders who both take their names from Ohio places.

11. ____________ Huge glacier ice sheets no longer exist.

12. ____________ The Rocky Mountains are the youngest mountains in North America.

13. ____________ The Grand Canyon was formed by the action of running water.

14. ____________ When magma cools slowly beneath the surface of the earth, small crystals generally are formed. The slower the cooling, the smaller the crystals.

15. ____________ Amethyst is purple quartz.

16. ____________ The first rocks on the earth were igneous rocks.

17. ____________ Fossils are always found in metamorphic rocks.

18. ____________ In the Cenozoic Era, plants reproduced only by spores.

19. ____________ Early man stayed in one place and did not wander from place to place.

20. ____________ Scientists think that man came from Asia to North America by way of the Bering Strait.

IV. Fill in the blanks.

1. ______________________________ was a scientist who believed man originated in Africa. He worked thirty years in Africa before he made his first discovery.

2. ______________________________ are the hardest mineral known.

3. ______________________________, _________________________, ____________________ are three of the characteristics of mammals.

4. Obsidian is known as ____________________ ____________________.

5. You can separate ______________________________ into layers. It often sparkles in the bright sunlight. It was once used in the doors of coal stoves, and windows in doors were once made of this mineral.

6. ________________________ was the metal used for many prehistoric ornaments. It turns green with age.

7. Animals that carry their young in a pouch are known as ______________.

8. The Ohio Historical Museum is located in the city of _______________.

9. The _________________________ appears to be holding an egg in its mouth.

Evaluation Sample (Cont.)
Grade 4
Unit: Geology -- Rocks and
Minerals

10. Huge chunks from glaciers are known as ____________________________.

11. Shale is a sedimentary rock that under heat and pressure can change to the metamorphic rock known as ____________________________.

12. __________________________________ is a mineral that has various colors such as rose, milky, purple, and clear.

13. The material that settles to the bottom of lakes, rivers, and oceans is known as ______________________________.

14. __________________________ is made from the shells and bones of sea animals.

15. The igneous rock that floats is called __________________________.

Unit Outline
Grade 4
Unit: Mystery Powders and
Solutions

Description of Unit: The unit on Mystery Powders and Solutions will provide fourth grade students with some basic fundamentals relating to the introduction of chemistry. The ESS teacher's guide and kit materials for Mystery Powders will provide children with many interesting and thought-provoking hands-on experiments. The teacher will have the option of supplementing the unit through the use of the ESS teacher's guide and materials kit for Colored Solutions.

In the Mystery Powders unit, students become familiar with some ordinary white powders and the use of indicators in identifying them and detecting their presence in mixtures. In learning to identify the powders and devising ways of distinguishing them from one another, students use some methods and techniques of investigatory science.

The supplemental unit, Colored Solutions, will enable children to perform experiments associated with density and the layering of liquids. The results of their experiments form a foundation of facts from which they are able to make predictions and draw reasonable conclusions.

I. Description of the Similarities and Differences of Mystery Powders (Sugar, Salt, Baking Soda, Starch, and Plaster of Paris)

   A. Texture
   B. Smell
   C. Color
   D. Crystal shape

II. Description of Positive Reactions of Simple Chemical Tests Performed on the Mystery Powders

   A. Heat test
   B. Iodine test for starch
   C. Vinegar test for acidity
   D. Water test

III. Identification and Classification

   A. Chart the results of testing done.
   B. Identify the compounds that have similar results.
   C. Identify unknown compounds.

IV. Class Discussion of Mystery Powders

   A. Describe behavior of substances when tested.
   B. Discuss the identities of the mystery powders.

V. This Unit of Study Lends Itself Very Well to a Classroom Science Center.

A. Set up the center with the white powders in containers.
B. Discuss with the class types of powders that are displayed.
C. Describe to the class the various tests they should perform to identify each powder. Explain how the results of their testing should be recorded.
D. Allow the class to work at the science center in their free time.
E. This center should occupy the children's interest for two to three weeks.
F. After pupils have completed their charts, a class discussion of their observations will further strengthen their understanding of the properties of white powders.

Suggested Activities
Grade 4
Unit: Mystery Powders and Solutions

OBJECTIVE: To determine the presence of starch in mystery powders

TITLE: "Iodine Test"

SOURCE: Mystery Powders, ESS Teacher's Guide

OBJECTIVE: To investigate the effect of water on the powders

TITLE: "Water Test"

SOURCE: Mystery Powders, ESS Teacher's Guide

OBJECTIVE: To examine the particles that make up each powder

TITLE: "Black Paper Test With Hand Magnifiers"

SOURCE: Mystery Powders, ESS Teacher's Guide

Resources
Grade 4
Unit: Mystery Powders and Solutions

Text Materials

Colored Solutions, ESS Teacher's Guide. McGraw-Hill.

Concepts and Challenges in Physical Science, Physics, Book 1. Cebco Standard Publishing, 1974.

Concepts and Challenges in Physical Science, Physics, Book 3. Cebco Standard Publishing, 1975.

Mystery Powders, ESS Teacher's Guide. McGraw-Hill.

Films -- Grandview Heights Public Library

Buoyancy, 14 min., 1968

How Things Dissolve, 16 min., 1968

Kits

ESS materials kit for Mystery Powders
ESS materials kit for Colored Solutions

Exemplary Activity
Grade 4
Unit: Mystery Powders and
Solutions

OBJECTIVE: To determine the effect of heat on the powders

MATERIALS AND EQUIPMENT: Hot plate, candles, or cans of Sterno; foil-wrapped cardboard; aluminum foil; wooden spring-clothespins

PROCEDURE:

Have each pupil make a small cup from the aluminum foil. Pour a small amount of one of the powders into the cup. Hold over the heat with a wooden clothespin. Heat the powder for several minutes or until no more changes occur.

RESULTS:

Baking soda and plaster of Paris seem to remain unchanged.
Salt snaps and crackles.
Starch turns brown and smells like burnt toast.
Sugar melts, bubbles, smokes, turns brown, turns black, and finally hardens.

Evaluation Sample
Grade 4
Unit: Mystery Powders and
Solutions

The use of a written test is usually not appropriate for this unit.

Identification of the mystery powders is an adequate evaluation tool, as it provides the pupils an opportunity to experiment and observe and to draw conclusions based on their observations. Students should also record data as they proceed with the various experiments and this can be used, in conjunction with class discussions, to evaluate a child's understanding of the unit concepts.

Unit Outline
Grade 4
Unit: Energy — Magnetism and Sound

Description of Unit: The two kinds of energy that are studied at the fourth grade level are magnetism and sound. The teacher has the option of whether to study each type of energy as a separate unit or combine the two into a larger unit on energy.

I. Magnetism

- A. Characteristics of magnetic energy
- B. The magnetic earth

II. Magnetic Materials

- A. Iron
- B. Cobalt
- C. Nickel
- D. Lodestone

III. Behavior of Magnets

- A. Unlike poles attract each other and like poles repel.
- B. The magnetic force is greatest at the ends or poles of the magnet.

IV. Definition of Sound

- A. What causes sound
- B. Sound waves
- C. How sound travels
- D. Hearing sound

V. Characteristics of Sound

- A. Pitch
- B. Loudness and intensity
- C. Quality of sound
- D. Beats
- E. Echoes
- F. Resonance

VI. Kinds of Sound

- A. Noise
- B. Musical sounds
- C. Human voice
- D. Animal sounds
- E. Stereophonic sounds
- F. Ultrasound

VII. Working with Sound

- A. Measuring sound
- B. Sound instruments
- C. Controlling sound
- D. Recording sound

OBJECTIVE: To listen, record, and classify sounds

TITLE: "Search for Sound"

SOURCE: Concepts in Science. Harcourt, Brace, Jovanovich, 1972, p. 10.

OBJECTIVE: To show how sound waves travel

TITLE: "Sound Waves"

SOURCE: Concepts in Science. Harcourt, Brace, Jovanovich, 1972, pp. 19 and 23.

OBJECTIVE: To find out what causes loud and soft sounds

TITLE: "Loud and Soft Sounds"

SOURCE: Concepts and Challenges in Physical Science, Physics. Cebco, 1975.

OBJECTIVE: To produce and see the effects of sound energy

TITLE: "Sound Energy"

SOURCE: Probing Into Science -- Sound. American Book Company, 1965.

OBJECTIVE: To show how size affects pitch

TITLE: "Percussion Musical Instruments"

SOURCE: Musical Instrument Recipe Book. ESS Teacher's Guide. McGraw-Hill.

OBJECTIVE: To gain more understanding of magnetic energy and its uses

TITLE: "What Is Magnetism?"

SOURCE: Concepts and Challenges in Physical Science, Physics. Cebco, 1975.

OBJECTIVE: To have hands-on experiences with different types of magnets and to "feel" a magnetic force

TITLE: "The Behavior of Magnets"

SOURCE: Concepts and Challenges in Physical Science, Physics. Cebco, 1975.

Resources
Grade 4
Unit: Energy -- Magnetism
and Sound

Text Materials

Brandwein, Cooper, Blackwood. Concepts in Science. Harcourt, Brace, Jovanovich, Inc., 1972, pp. 3-39.

Concepts and Challenges in Physical Science, Physics, Book 1. Cebco Standard Publishing, 1974.

Concepts and Challenges in Physical Science, Physics, Book 3. Cebco Standard Publishing, 1975.

Jacobson, Lauby, Konicek. Probing Into Science. American Book Co., 1965, pp. 165-167.

Musical Instrument Recipe Book. ESS. McGraw-Hill Book Co., 1971.

Tannenbaum and Stillman. Teacher's Manual for Sound. McGraw-Hill Book Co., 1967.

Whistles and Strings. ESS. McGraw-Hill Book Co., 1971.

Films

Strands Grow, 14 min., color. Grandview Heights Public Library.

Toot, Whistle, Plunk and Boom, 10 min., color. Grandview Heights Public Library.

You and Your Ears, 10 min., color, Disney cartoon. Ohio Department of Health.

Filmstrips -- School Library

Finding Out About Sound

Light, Heat and Sound

Kits and Materials

100 Invitations to Investigate. No. 2, "The Pitch of Sound" and No. 21, "Radio Waves." Harcourt, Brace, World. School IRC.

Tuning forks, magnets, iron filings

COETV

"Science Room" for intermediate grades, Unit V: Communications. Three lessons: "Sound and Communications," "Television," and "What Is Sound?"

Library Resource Books

Baer, Marian. Sound.

Geralton, James. The Story of Sound.

Irving, Robert. Sounds and Ultrasonics.

Kettlekamp, Larry. The Magic Sound.

Knight, David. First Book of Sound (easy to read).

Ripper, Charles. Bats.

Windle, Eric. Sounds You Cannot Hear.

Audiometer -- Nurse's Office

Exemplary Activity
Grade 4
Unit: Energy -- Magnetism
and Sound

OBJECTIVE: To produce and see the effects of sound energy

MATERIALS AND EQUIPMENT: Cardboard tube 1-1/2 inches in diameter, small cone of paper, balloon, candle in a dish

PROCEDURE:

Make a cone of paper. The big end of the cone should be just a little wider than the tube. The small end of the cone should have an opening about a quarter of an inch across. Tape the large end of the cone over one end of the tube. Over the other end of the tube, attach a piece of a balloon.

Place a lighted candle in a small dish or holder. Support the tube, perhaps on several books, so that the point of the cone is at the same height as the candle flame. The open end of the cone should be a few inches from the candle flame.

Clap your hands together near the rubber-covered end of the tube. Watch the candle flame. What happens?

The balloon did not allow air to enter the tube. What made the flame flicker?

OBJECTIVE: To have hands-on experiences with different types of magnets and to "feel" a magnetic force

MATERIALS AND EQUIPMENT: Magnets, iron filings, sheet of glass, a thin board, an old phonograph record, a piece of cardboard, a metal lid, paper clips, and nails

PROCEDURE:

Magnetism will pass through some materials and not others. Obtain a sheet of glass, a thin board, an old phonograph record, a piece of cardboard, and the lid of a large tin can. Place a thumbtack on each of these objects and move a strong magnet under them. If the tack can be moved through the object, the magnetism must be passing through. This will not happen through the can lid (or any other object made of iron). Let the children experiment, observe, and discuss until they discover that magnetism does not pass through materials that are magnetic.

Lay a strong bar magnet under a sheet of glass (or stiff cardboard). Sprinkle iron filing over the glass and note the pattern formed. Gently tapping the edge of the glass will help the magnetic pattern form. Blueprints of the magnetic fields can be made by substituting blueprint paper for the glass and exposing it to strong light.

Provide the children with bar magnets and paper clips. Allow children the opportunity to "feel" the effect on the clips and other objects of various materials.

Provide each child or small group of children with a pair of bar magnets, and ask them to determine how the magnets affect each other. From observations made by children, develop some generalizations about the behavior of magnets, such as: the strength of a magnet is located at its ends or poles; unlike poles attract each other; and either end of a magnet will attract iron.

Children may make small magnets by magnetizing common nails. Give each child a 4-inch nail, a bar magnet, and some paper clips. Have children stroke the nails in one direction with one end of the magnet (not with a back and forth motion) about 25 times. Use magnetized nail to pick up clips. How many can be lifted by the nail? Drop the nail on the floor a few times to determine the effect of dropping on a magnet. Will it pick up as many clips?

To show that any object that is attracted to a magnet has itself become a magnet, have children touch a paper clip to the end of a magnet. Touch a second clip to the bottom of the first. If the magnet is fairly strong, a sizable chain can be constructed by this process. Why do the clips stay together? Remove the first clip from the magnet to see how long the magnetism lasts.

Evaluation Sample
Grade 4
Unit: Energy -- Magnetism
and Sound

Teacher-made test for evaluating Sound Energy.

1. Name the 3 things necessary for hearing a sound.

   1. ________ 2. ________ 3. ________

2. Name 3 things sound can travel through.

   1. ________ 2. ________ 3. ________

3. What did the experiment show when we hit the cymbals together?

   ____

   ____

4. How fast does sound travel per second? ________

5. Which travels faster, sound or light? ________

   How do we know? Give an example. ________

   ____

6. Remembering the experiments you saw, name as many ways as you can that cause different sounds.

   ____

   ____

   ____

7. What did we use in an experiment to demonstrate that we could hear vibrations?

   ____

8. What was used so that we could see vibrations? ________

9. What was used so that we could feel vibrations? ________

10. Use your dictionary and write the definition for vibration.

    ____

    ____

Unit Outline
Grade 4
Unit: Insects and the
Behavior of Mealworms

Description of Unit: The study of insects will be centered mostly around the ESS unit Behavior of Mealworms. Students will be stimulated to ask questions about the observable behavior of a familiar animal and then be directed to ways in which they can find the answers for themselves. Children will learn skills in the process of scientific inquiry by experimenting, observing, and recording. Teachers will be provided with the necessary kit materials, teacher's guide, and certificates for redeeming a supply of live mealworms. The study of other types of insects may be incorporated into the unit.

I. Characteristics

   A. Life cycle
      1. Larva
      2. Pupa
      3. Adult
   B. Eating habits
   C. Movement/locomotion

II. Environmental Facts

   A. Food
   B. Light
   C. Humidity (moisture)
   D. Temperature

III. Behavior

   A. Sensory (sight and touch)
   B. Responses to stimuli

Suggested Activities
Grade 4
Unit: Insects and the
Behavior of Mealworms

OBJECTIVE: To discover many of the physical and behavioral characteristics of the mealworm

TITLE: "Recording Observations"

SOURCE: Behavior of Mealworms, ESS manual, p. 2

OBJECTIVE: To discover the method of locomotion and eating

TITLE: "Walking and Eating"

SOURCE: Behavior of Mealworms, ESS manual, pp. 8, 24

OBJECTIVE: To determine if mealworms prefer a certain color

TITLE: "Preference of Color"

SOURCE: Behavior of Mealworms, ESS manual, p. 22

OBJECTIVE: To assist students in discriminating between different types of insects; to understand the important role the insects play in our environment

TITLE: "What Kind of a Bug Is This?"

SOURCE: Teacher developed activity to be conducted at the Upper Arlington Schools' Land Laboratory

Resources
Grade 4
Unit: Insects and the
Behavior of Mealworms

Text Materials

Behavior of Mealworms, ESS Teacher's Guide. Webster Division, McGraw-Hill.

Exploring Science, Green Book. Laidlaw Brothers, 1979.

Probing Into Science -- Insects. American Book Company, 1967.

Science, Understanding Your Environment. Silver Burdett, 1978.

SPIES: Plants and Animals. Silver Burdett, 1976.

Films -- Grandview Heights Public Library

Grassblade Jungle, 11 min., 1960

Insects, 11 min., 1957

Nature's Half Acre, 33 min., Disney, 1955

Secret in the Hive, 32 min., 1970

Filmstrips

Filmstrips on insects available from school library and IRC

Transparencies

Insects. Milliken transparency book. Available from the school science room.

Kits

ESS materials kit for Behavior of Mealworms
A coupon for redeeming live mealworms that will be delivered to the school

Outdoor Biology Instructional Strategies (OBIS) -- Sets I, II, III and IV

Exemplary Activity
Grade 4
Unit: Insects and the
Behavior of Mealworms

OBJECTIVE: To discover many of the physical and behavioral characteristics of the mealworm

MATERIALS AND EQUIPMENT: Stenographer's tablet or small notebook, individual containers for mealworms, bran flakes, cut-up apple

PROCEDURE:

1. Record daily observations made of the mealworm, noting changes in physical characteristics.
2. Perform simple experiments, such as color preference, tapping with a pencil, and making a maze; record results in a notebook.
3. Make simple drawings of physical characteristics.

Evaluation Sample
Grade 4
Unit: Insects and the
Behavior of Mealworms

The notebooks in which the children have recorded their observations, results of the experiments, and class discussions are the best evaluation tool to be used for this unit. As a supplement, the children could make dioramas, mazes for the experiments, or draw detailed pictures.

Unit Outline
Grade 4
Unit: Conservation and
Stream Tables

Description of Unit: A stream table is a waterproof box containing sand, water, dirt, and gravel; with a pump to circulate water and tubing to create currents and streams, it simulates a miniature world. Within it, children create mountains, ocean waves, storms, and lakes, reproducing nature's own effects.

The stream table promotes group cooperation and the acceptance of ideas and suggestions. Allow the children to assist in setting up the stream table. This permits them to manipulate the materials and to understand the function of each item. Also, this action promotes responsibility for taking care of the apparatus.

Set-up: fold and score the cardboard;
tape the corners with duct tape;
line the cardboard with sand;
set in the plastic liner;
set up the pump assembly;
pour three bags of sand and 15-20 gallons of water into the table; washing the sand with a hose will eliminate a large buildup of silt.
(Three qualities of sand can be purchased at Columbus Builder's Supply in 80 pound bags.)

The initial class activities in the stream table should promote active individual interaction with the apparatus. In the first class period, stress reasons for turning off the electricity should the pump ever happen to fall into the water.

Be sure to supervise the stream table activity. Occasionally, water and sand will spill on the floor. Therefore, a sponge and bucket should be handy. At the end of a lesson, 10-20 minutes, have the students wash the sand off their hands and arms into the water end of the table before they wash in the sink. This precaution will prevent clogged sinks.

Only 7-8 students can be accommodated at the table at one time. Therefore, the activity could be coordinated with an independent reading, social studies, or math activity.

I. The student will construct and investigate a variety of water streams in a stream table.

II. The student will construct lakes in a stream table and investigate their behavior.

III. The student will construct mountains in a stream table and investigate their interaction with water streams.

IV. The student will identify specified geographical formations.

V. The student will construct and describe earthquakes in the stream table.

Suggested Activities
Grade 4
Unit: Conservation and
Stream Tables

OBJECTIVE: To compare a long straight stream with a curving stream. How are they alike? How are they different?

TITLE: "Different Types of Streams"

SOURCE: Stream Tables, ESS Teacher's Guide

OBJECTIVE: To build a dam and make observations. Place your hose behind the dam. When the dam breaks, observe the stream created for 5 minutes. What changes did you notice?

TITLE: "Constructing a Dam"

SOURCE: Stream Tables, ESS Teacher's Guide

OBJECTIVE: To enable the student to determine the speed of water streams of varying lengths. Use string to measure the length of the stream. Use corks to determine the speed of the water.

TITLE: "How Fast Does Water Flow?"

SOURCE: Stream Tables, ESS Teacher's Guide

OBJECTIVE: To let the student construct a bridge over a water stream out of cardboard. Add weights or matchbox cars to the structure. How long will a bridge stand as a water stream passes beneath the bridge? How can the bridge construction be varied to make the bridge stand longer?

TITLE: "Constructing a Bridge"

SOURCE: Stream Tables, ESS Teacher's Guide

OBJECTIVE: To let the student construct a variety of lakes with sand and water. How long will it take to empty a given lake or lakes? Given a ruler, the student will measure the depth of a constructed lake at specific time intervals to determine the time when the lake is emptying fastest or slowest.

TITLE: "Build Me a Lake"

SOURCE: Stream Tables, ESS Teacher's Guide

OBJECTIVE: To enable the student to construct mountains in a stream table and investigate their interaction with streams. The student will determine the length of time it takes a mountain to collapse when streams of water are placed at varying positions on the mountain

TITLE: "Down Comes the Mountain"

SOURCE: Stream Tables, ESS Teacher's Guide

Resources
Grade 4
Unit: Conservation and
Stream Tables

Text Materials

Concepts and Challenges in Earth Science, Book 1. Cebco Standard Publishing, 1974.

Concepts in Science. Harcourt, Brace, Jovanovich, 1972, pp. 164-176, 183-184.

Discovering With Science. Ginn and Company, 1967, pp. 226-230.

Exploring Science, Green Book. Laidlaw Brothers, 1979.

The Prehistoric World. The Warwick Press, 1975.

Science Is Experimenting. Scott Foresman, 1968, pp. 106-117.

Science, Understanding Your Environment. Silver Burdett, 1978.

Stream Tables. ESS Teacher's Guide.

Films -- Grandview Heights Public Library

Face of the Earth, 12 min., 1954

Mountains, Plains, Plateaus, 18 min., 1971

A Stream Environment, 9 min., 1972

Filmstrips -- School Library

Saving Our Soils, Britannica Film Library

Soils I

Using Natural Resources

Transparencies

Ecology. Milliken transparency book. Available from school science room.

Kits

ESS materials kit for Stream Tables

Exemplary Activity
Grade 4
Unit: Conservation and
Stream Tables

OBJECTIVE: To construct and investigate a variety of water streams in a Stream Table

MATERIALS AND EQUIPMENT: ESS teacher's guide and materials kit for Stream Tables

PROCEDURE:

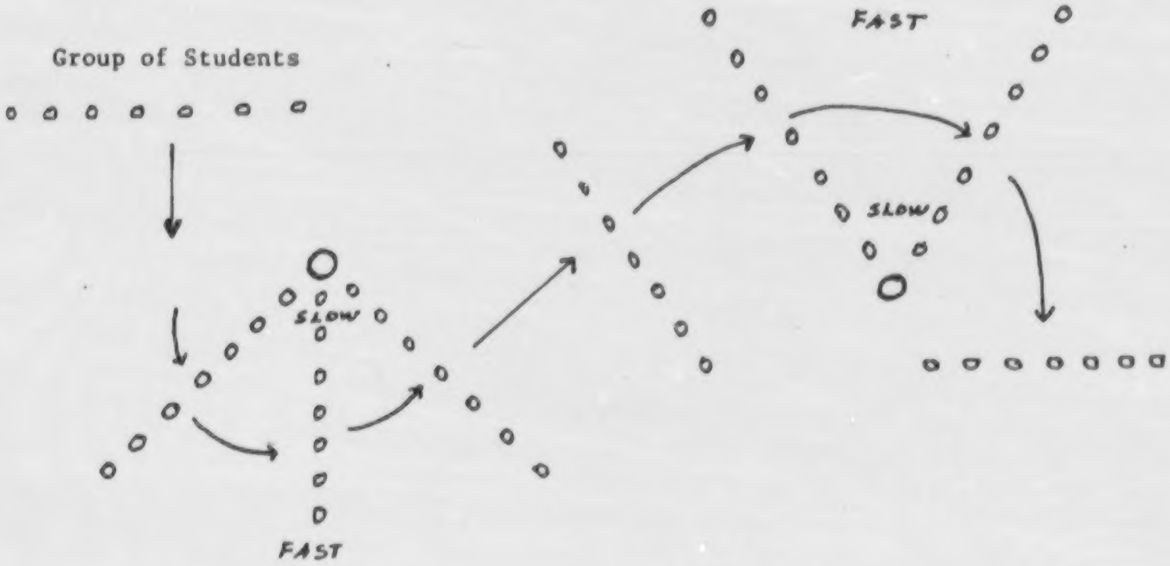
Have the students construct a curving stream with at least two large curves. Observe the water as it travels down the stream. What do you notice?

Possible responses:
- a. sand builds up on one side
- b. sand wears away on the other side
- c. water moves fastest on the outside of the curve

Which side of the stream is moving fastest?
Which side of the stream is moving slowest?
How did you decide upon your answer?

RELATED ACTIVITY:

Have the children simulate a curving stream. Have them notice the speed they must travel as they go around the corners. Which end of the line moves fastest? Which end of the line moves slowest? Which group would wear away the soil? Which group would drop its soil? (Be sure to keep the groups in a straight line as they travel around the corners.)



Evaluation Sample
Grade 4
Unit: Conservation and
Stream Tables

1. Running water can carry soil because it has

   a. energy b. wetness

2. The faster water runs, the

   a. less soil it can carry
   b. more soil it can carry

True or False

3. ____ Running water can change the land.

4. ____ The slower water travels, the larger the stones it can carry.

Completion

5. What does it mean when the water of a river is muddy?

6. Where do the soil and rocks that are carried by a river come from?

7. Where does a river that is curving deposit its soil?

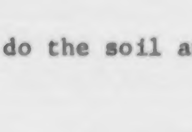
8. Suppose a river is carrying along heavy particles as well as light particles of soil and sand. What do you think will happen to the particles if the water slows down?

9. Land is built up at the mouth of the river as soil is

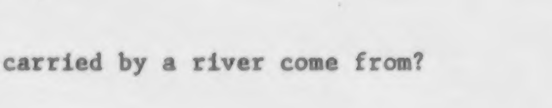
   a. dropped b. carried away

10. Which of these rivers is moving faster and which one is moving slower?

a.



b.



11. Draw a picture of a winding stream. Describe how the speed of different sides of the stream is different.

Unit Outline
Grade 4
Unit: Peas and Particles

Description of Unit: The unit on Peas and Particles is primarily a study of mathematics with special emphasis on the scientific process of estimation. Its purpose is to give children a real understanding of large numbers and how these may apply to their daily lives. The unit is designed to be presented to children in the spirit of exploration and the activities may be conducted in an informal manner.

I. Learning a Variety of Ways to Estimate and Count

   A. Handful estimations
   B. Bag estimations
   C. Jar estimations

II. Experimenting With Some Counting Methods

   A. Counting one by one
   B. Taking a sample
   C. Counting by area
   D. Halving
   E. Weighing
   F. Ratios

III. Class Discussion of Peas and Particles

   A. Rounding off
   B. Orders of magnitude
   C. Applying estimation in and around the school
   D. Questions from a research box
   E. Where is estimation used?
   F. Making a million

Suggested Activities
Grade 4
Unit: Peas and Particles

OBJECTIVE: To help students extend their feeling for numbers from just three or four up to the tens and twenties

TITLE: "How Many Balloons Are in the Picture?"

SOURCE: Peas and Particles, ESS Teacher's Guide

OBJECTIVE: To emphasize the value of estimating and the need sometimes for an exact number

TITLE: "How Many Students Are in Our School?"

SOURCE: Peas and Particles, ESS Teacher's Guide

OBJECTIVE: To demonstrate to students that there are many different ways of arriving at good estimations

TITLE: "How Many Hairs on a Person's Head or Freckles on His/Her Face?"

SOURCE: Peas and Particles, ESS Teacher's Guide

Resources
Grade 4
Unit: Peas and Particles

Text Materials

Peas and Particles, ESS Teacher's Guide.

Peas and Particles Picture Packet. McGraw-Hill.

Kits

Peas and Particles, ESS Materials Kit. Circular meter wheel, tape measures, scales, and measuring containers from science room.

Exemplary Activity
Grade 4
Unit: Peas and Particles

OBJECTIVE: To demonstrate that the scientific processes of estimation are valuable tools that can help us in our everyday lives

MATERIALS AND EQUIPMENT: The ESS materials kit provided with the unit

PROCEDURE:

I. A. How many balloons are in the picture? ____________

B. Estimate the following items:

	Estimated in the teacher's hand	Estimated on the paper	By actual count
1. Beans			
2. Peas			
3. Styrofoam balls			

II.

	What's in the jar?	Number guessed	Number counted
1.			
2.			
3.			
4.			
5.			

Explain in detail the methods used for estimating.

Evaluation Sample
Grade 4
Unit: Peas and Particles

It is suggested that each student keep a notebook and record all information relating to the estimation processes. As the students discover different and better methods of estimating, they should explain and record this data in the notebook. The class discussions will also be helpful in evaluating a student's understanding of the unit. If the teacher desires a more formal evaluation of the unit, a "practical" test could be easily devised whereby students would have to make various types of estimations and explain their reasons for using each method of estimating.

Unit Outline
Grade 5
Unit: Electricity --
Batteries and Bulbs

I. Kinds of Electricity

   A. Static
   B. Current -- direct and alternate
   C. Magnet-generated electricity

II. Electrical Charges

   A. All objects are made up of atoms.
   B. Construction of an atom
      1. Protons
      2. Electrons
      3. Neutrons
   C. Like charges repel and unlike charges attract.

III. Flow of Electricity

   A. Conductors carry electricity from place to place -- most metals
   B. Nonconductors do not transmit electricity -- insulators
      1. Common insulators
         a. Glass
         b. Cloth
         c. Rubber
   C. Complete circuits -- series and parallel
   D. Incomplete circuits
      1. Part of circuit removed
      2. Switches
      3. Removal of fuses
      4. Circuit breaker

IV. Uses of Electricity

   A. Heating
   B. Lighting
   C. Mechanical energy

Suggested Activities
Grade 5
Unit: Electricity --
Batteries and Bulbs

OBJECTIVE: To spark interest in experimenting with batteries and bulbs. Students will draw pictures of what works and what does not work during their experimenting.

TITLE: "What Works and What Does Not?"

SOURCE: Batteries and Bulbs, ESS Teacher's Guide and kit. Use the Batteries and Bulbs Cards in kit for ideas.

OBJECTIVE: To discover the effects of different charges on various materials through the use of an electroscope

TITLE: "What Charge Is This?"

SOURCE: Electricity. Booklet by Willard J. Jacobson, 1965, p. 189.

OBJECTIVE: To construct a system to determine materials that conduct electricity and those that do not (materials to be tested can be taken from a "junk" box)

TITLE: "Conductor or Insulator?"

SOURCE: Batteries and Bulbs Kit. Selective Educational Equipment (SEE), 1972, cards F-1 through F-5.

Resources
Grade 5
Unit: Electricity --
Batteries and Bulbs

Text Materials

Batteries and Bulbs. ESS Teacher's Guide.

Batteries and Bulbs, Part II. ESS Teacher's Guide.

Concepts and Challenges in Physical Science, Book 1. Cebco Standard Publishing.

Gateways to Science. McGraw Hill, 1979.

Jacobson, Willard J. Electricity. American Book Co., 1965.

Schneider, Herman and Nina. Science in Our World. Heath and Co., 1965, pp. 135-159.

Science, Understanding Your Environment. Silver Burdett, 1978.

Films -- Grandview Heights Public Library

Learning About Electric Current

Story of Magnetism

Filmstrips

Magnetism and Electricity -- school library or IRC

Transparencies

Electricity and Magnetism -- science room or IRC

Kits and Materials

ESS materials kit for Batteries and Bulbs
Activity cards and student worksheets for Batteries and Bulbs
Buzzers, bells, generator, and a steam engine model

Exemplary Activity
Grade 5
Unit: Electricity --
Batteries and Bulbs

OBJECTIVE: To test and infer connections between terminals of an electric Mystery Box

MATERIALS AND EQUIPMENT: From Batteries and Bulbs Kit -- #22 plastic-covered copper wire, 48 Fahnestock clips, 6 shoe boxes, 1 nail, 48 brass paper fasteners, 1 roll masking tape

PROCEDURE:

Using a nail, punch eight holes in the top of a shoe box or any other box of similar size that can be sealed. Number these holes one through eight.

Put a paper fastener through each hole so that the head stays on top of box and looks like a button. Before opening the paper fastener on the underside of box top, insert a Fahnestock clip on each fastener. Then close the fastener onto the Fahnestock clip.

Strip one inch of insulation from each end of four or five box-length pieces of plastic-covered wire. Connect the ends of the wires in a pattern. You should plan to use four or five wires inside each box. Put the lid on the box and seal the box with masking tape.

To make up a tester for the boxes, see ESS Batteries and Bulbs Teacher's Guide, p. 38.

Evaluation Sample
Grade 5
Unit: Electricity --
Batteries and Bulbs

The evaluation sample is a programmed learning device on electricity that appeared in the January/February 1975 edition of Science Activities. The device, entitled "Electricity Quiz," was developed by Harrie E. Caldwell and Ralph Hahn.

Unit Outline
Grade 5
Unit: The Individual and
the Environment

Introduction to The Individual and the Environment: The individual is a part of the environment and all actions from the individual will affect the environment -- the land, the water, the air, and the living things of earth. Individuals should become aware of the many changes they may cause and of the probable consequences of harmful misuses of the environment. Therefore, individual responsibility must be assumed for maintaining a safe and healthful environment.

I. The Earth as a Self-Contained Life Support System

   A. Air
   B. Water
   C. Soil
   D. Plants
   E. Animals
   F. Minerals

II. The Earth and Its Many Ecosystems

   A. Dependence upon the sun's energy
   B. Dependence upon the earth's environment

III. Cultural Development Has Resulted in the Changing of Our Environment

   A. Pollution
   B. Reduction of natural resources
   C. Destruction of plant and animal habitats

IV. Current Environmental Problems

   A. Fuel sources
   B. Changes in the atmosphere
   C. Destruction of natural resources
   D. Population expansion

V. Immediate and Long-Term Solutions to Environmental Problems

   A. Better management of natural resources
   B. Educating the individual and changing of values

Suggested Activities
Grade 5
Unit: The Individual and
the Environment

OBJECTIVE: To discover the types and sizes of materials that make up soil

TITLE: "What Makes Up Soil?"

SOURCE: Science Activities, Fall 1978, Volume 15 No. 3, pp. 12-13

OBJECTIVE: To discover if air pollution is evident in our community

TITLE: "Set Traps for Particulates"

SOURCE: Our Environment: Problem or Promise. Kit from Nystrom Company

OBJECTIVE: To show that air pollutants have destructive effects upon animals, plants, and nonliving materials

TITLE: "Effect of Air Pollutants on Various Materials"

SOURCE: Environmental Pollution Module, Educational Modules, Inc.,
266 Lyeel Avenue, Rochester, N.Y. 14608

OBJECTIVE: To demonstrate the importance of wildlife in our ecosystem and to encourage positive attitudes toward plant and animal management

TITLE: "Where Did All of Those Rabbits Come From?"

SOURCE Teacher developed activity to be conducted at the Upper Arlington Schools' Land Laboratory

Resources
Grade 5
Unit: The Individual and
the Environment

Text Materials

Concepts and Challenges in Earth Science, Book 2. Cebco Standard Publishing Company.

Gateways to Science. McGraw-Hill, 1979.

Science, Understanding Your Environment. Silver Burdett, 1978.

SPIES: Ecology. Silver Burdett, 1976.

SPIES: Skill Builders. Silver Burdett, 1976.

Films -- Grandview Heights Public Library

At the Crossroads, 26 min.

Cry of the Marsh, 12 min.

Face of the Earth, 12 min.

John Muir's High Sierra, 27 min.

One Day at Teton Marsh, 48 min.

Problems of Conservation: Our Natural Resources, 11 min.

Rise and Fall of the Great Lakes, 17 min.

Why Plants Grow Where They Do, 11 min.

Wild River, Parts I and II, 52 min.

Filmstrips -- School Library

Biological Communities I

Biological Communities II

Biological Relationships

Biological Succession

Enough Water for Everyone

Improving Our Grasslands

Filmstrips (Cont.)

Introduction to Ecology

Living Things Need Food

Man and Ecology

Meaning of Conservation

Metals and Nonmetals

Saving Our Soil

Soil and Its Uses

Soils I

Using Our Forests Wisely

Using Our Minerals Wisely

Water I

Water II

What Is Conservation?

Transparencies

Ecology. Milliken transparency book. Available from science room.

Pamphlets

Available from Ohio Environmental Protection Agency, 369 E. Broad Street, Columbus, OH 43215.

Kits

Earth, Oasis in Space (Scholastic)

Ecology and Energy (McDonalds)

Environment of Man (New York Times)

Environmental Pollution Module (Educational Modules)

Kits (Cont.)

Environmental Rummy game

Exploring Career Group 3 (SVE)

Our Environment: Problem or Promise (Nystrom)

Outdoor Biology Instructional Strategies (OBIS) -- Sets I, II, III and IV

Exemplary Activity
Grade 5
Unit: The Individual and
the Environment

OBJECTIVE: To demonstrate the deteriorating effect of air pollutants on various materials. Air pollutants have destructive effects upon animals, plants, and nonliving materials; they are suspected of upsetting the ecological relationship between the living and nonliving things in nature; the discolored stone facing on buildings and rapid deterioration of steel demonstrate that even nonliving materials cannot escape the destructive effect of air pollution.

MATERIALS AND EQUIPMENT: Collection bottles containing H_2S and SO_2; metal objects -- steel, silver, copper; plants -- lettuce, radish, ragweed, alfalfa; lead-based painted strips; nylon stocking

PROCEDURE:

The following activity is from the Environmental Pollution Module, Educational Modules, Inc., 266 Lyeel Avenue, Rochester, N.Y. 14608.

Teachers may require the assistance of the science consultant in making the gases.

1. H_2S and Metals

   a. Hydrogen sulfide is very reactive with metals, forming metallic sulfides. It can blacken lead-based house paints and tarnish copper and silver. The city housewife who must laboriously polish her silverware to remove the silver sulfide (tarnish) can blame the sulfur pollutants in the air.

   b. Place a silver (iron, copper) object and a strip of lead-based paint in a collection bottle filled with H_2S. Cap and let stand until noticeable results appear (the paint will darken instantaneously). Similar control objects that are not exposed to H_2S should be available for comparison. Faster results can be achieved by adding a drop of H_2S water solution ("rain") to the objects tested. The H_2S water solution can be prepared by adding 15 ml of water to the collection bottle and shaking it for three (3) minutes.

2. SO_2 and Plants

   a. Sulfur dioxide, one of the most widespread pollutants, produces two types of injury to the leaves of plants: acute and chronic. Acute injury kills the leaf tissue in the interveinal and marginal areas. At first the tissue assumes a water-soaked appearance; later it bleaches white. Chronic injury is caused by low exposure and produces leaf markings, but does not destroy the tissue. Sulfuric acid mists produce large and small spots on the upper surface of leaves.

   b. Lettuce and radish plants can be started from seeds growing in small pots or small ragweed plants can be transplanted. A large airtight transparent container (jar) can be used as a fumigation chamber. The

(b) container should be large enough to hold three or four potted plants. Fill the chamber with SO_2 by dropping H_2SO_4 into the generating bottle containing sodium sulfite or by burning sulfur in a combustion spoon. The generating bottle should be placed on the inside bottom of the fumigation chamber so that the gas collects inside. Place the plants inside the chamber and remove them, one at a time, at 15- or 30-minute intervals. In a few days, observe the damage, compared with a plant that was not exposed. Perform the experiment in a well-lighted area, since the leaf stomata must be open to allow the gas to enter the leaf.

3. SO_2 and Nylon and Metals

a. Sulfur dioxide is believed to be oxidized in the air to sulfur trioxide (SO_3), which reacts with water to form a sulfuric acid aerosol (mist). Not only is this aerosol highly destructive to living materials, it is also destructive to fabrics and metals. Nylon hose deteriorate much faster in polluted cities, due to the sulfuric acid aerosol.

b. Stretch a nylon stocking over an open jar and secure it in place with a rubber band. Place a few drops of sulfuric acid (H_2SO_4) on the nylon and observe every few hours. The acid used is at a higher concentration (USE CARE IN HANDLING) than that found in polluted air, but the effect is the same, except faster. The acid may also be applied to various metals to observe its destructive effect. Some metals will react faster than others (aluminum reacts faster than lead); some will not react at all (copper) and can withstand pollution for long periods of time.

Evaluation Sample
Grade 5
Unit: The Individual and
the Environment

The fifteen questions listed below are to be answered and assembled in a notebook prepared by each student. Student activities and projects are also included in the total evaluation of the unit. Points could be assigned for questions, activities, and projects, and a contract system could also be used.

A. Ecology/The Earth

1. What is ecology?
2. Draw a web of nature.
3. Explain an ecosystem.

B. Air

4. Make a drawing of the atmosphere. Label the layers.
5. Name the gases in the air.
6. What is air pollution?
7. How does air pollution affect our health?

C. Water

8. Draw and label a water cycle.
9. Why is water so essential for life?

D. Land

10. In what ways do we use land?
11. Make and label a drawing of the soil layers.
12. What are the characteristics of the soil?

E. Problems and Solutions/Responsibilities Present and Future

13. Why are we concerned about our life support system?
14. List some of the current environmental problems.
15. Who is responsible for stopping pollution? Why?

Unit Outline
Grade 5
Unit: Weather and Seasons

I. Forces That Cause Weather and Seasons

  A. Water cycle
  B. Sun's heat on earth and angle of sun's rays upon earth
  C. Air in atmosphere

II. Elements of Weather

  A. Wind
  B. Pressure
  C. Temperature
  D. Humidity
  E. Clouds
  F. Precipitation

III. Causes of Weather Changes

  A. Wind patterns
  B. Unequal heating of air
  C. Wind direction
  D. Wind speed
  E. Revolution of earth around sun
  F. The tilting of the earth in its axis as it revolves around the sun

IV. Instruments to Measure Weather

  A. Thermometer -- temperature
  B. Barometer -- air pressure
  C. Hygrometer -- humidity
  D. Rain gauge -- precipitation
  E. Anemometer -- surface wind speeds

Suggested Activities
Grade 5
Unit: Weather and Seasons

OBJECTIVE: To verify that air has weight; to understand that changes in the pressure of the air occur causing weather to change

TITLE: "Pressure We Can't See"

SOURCE: Concepts and Challenges in Earth Science, Book 2. Cebco Standard Publishing Co.

OBJECTIVE: To help children understand that evaporation and condensation of water in the atmosphere result in the water cycle

TITLE: "Water in the Air"

SOURCE: Science, Understanding Your Environment. Silver Burdett, 1978.

OBJECTIVE: To help children understand that air in motion is wind and that wind is caused by changes in temperature of the air

TITLE: "Air in Motion"

SOURCE: Weather, Teacher's Guide. McGraw-Hill Experiences in Science.

Text Materials

Adventuring in Science. Ginn and Co., 1961, pp. 24-63.

Climate and Weather. Compton's Encyclopedia Reprint, 1973.

Concepts and Challenges in Earth Science, Book 2. Cebco Standard Publishing Co.

Concepts in Science. Harcourt, Brace, Jovanovich, 1972, pp. 59-60.

Gases and Air. ESS Teacher's Guide.

Gateways to Science. McGraw-Hill, 1979.

The New Air Book. Thomas Crowell Company, 1974.

The Reasons for Seasons. Little, Brown and Company, 1975.

Science, Understanding Your Environment. Silver Burdett, 1978.

SPIES: Ecology. Silver Burdett, 1976.

SPIES: Skill Builders. Silver Burdett, 1976.

Weather. New York: Golden Press.

Weather maps from newspapers, Citizen-Journal and Columbus Dispatch

Films -- Grandview Heights Public Library

Clouds Around Me

Weather Forecasting

Whatever the Weather

Filmstrips -- school library or IRC

Air, Wind and Weather

Everyday Weather and How It Works

Exploring the Weather

How and Why Weather

Hurricanes and Twisters

Filmstrips (Cont.)

Hurricanes, Tornados and Blizzards

Let's Find Out About Weather

Lightning and Thunder

The Story of Air

Weather -- Life Science Library

Why Does the Weather Change

Transparencies

Weather and Man. Transparencies from Scholastic Magazine, 1973.

Weather Science. Transparencies books in science room and school library.

Materials

Thermometers, barometer, and hygrometer

Exemplary Activity
Grade 5
Unit: Weather and Seasons

OBJECTIVE: To discover what makes the wind blow

MATERIALS AND EQUIPMENT: Convection box from science room, candle, wooden splints

PROCEDURE:

1. Set up the convection box.
2. Place a lighted candle under one chimney.
3. Close the box with the glass plate.
4. Hold a smoking splinter of wood over the chimney above the candle. (The smoke rises.)
5. Hold the smoking splint above the other chimney. (The smoke passes down through that chimney, across the box, and up the other chimney.)

The air around the candle was heated and became lighter. The air above the other chimney was cooler and therefore heavier. This cooler, heavier air came down through the chimney, moved across the box, and forced the warmer, lighter air around the candle up the chimney above it.

In the same way, great volumes of air around the earth are heated by the sun. This warm air becomes lighter and is forced upward by the cooler surrounding air. This in turn causes horizontal movements of air that are called winds. Winds are caused by unequal temperatures of air.

OBJECTIVE: To show that air exerts pressure

MATERIALS AND EQUIPMENT: 1 empty gallon metal can with tight-fitting cap, Bunsen burner or hot plate, small amount of water

PROCEDURE:

Put small amount of water in can. Heat the water with hot plate or Bunsen burner until steam comes out of opening in top of can. Quickly remove can and cap opening tightly. Atmosphere pressure will collapse the can since the pressure is greater on the outside of the can.

OBJECTIVE: To permit children to work independently and in small groups researching questions for reports and notebooks for the weather unit

MATERIALS AND EQUIPMENT: 3 x 5 cards with explanations of experiments to be performed; weather chart for daily weather record; books on weather from library; filmstrips, filmstrip projector; posted list of weather instruments and what they tell us; posted list of vocabulary of weather terms with definitions

Bunsen burner
hot plate
balloons
yardstick
thermometers
globe and flashlight
barometer
hygrometer
wooden stand
clay
tubing (plastic)
cloth
pop bottle
2 beakers
metal tray
dry soil
pie tins
2 glass jars, screw lids
straws
paper
cardboard, nails
rulers
2 tin cans
glass tubes
2 rubber balls
2 sticks
2 empty milk cartons
shallow can
rubber bands
glue

PROCEDURE:

Use experiments such as the following to demonstrate some of the basic concepts related to weather science. Copy the experiments on 3 x 5 cards so children can use them independently.

1. Demonstrate that air has weight. Balance two inflated balloons on either end of a yardstick. Deflate 1 balloon and the apparatus will go out of balance.

2. Demonstrate that hot air expands and cold air contracts. Fill 2 balloons equally. Put one in a freezer. Put the other over a hot air register.

3. Make a daily weather record for the class and for each student. Record the following: (a) temperature, (b) humidity -- use a wet-bulb-dry-bulb hygrometer and chart, (c) wind speed -- use wind speed indicator or have children estimate, (d) wind direction -- record what direction the wind is coming from, (e) cloud coverage -- the percentage of sky that is covered by clouds, and (f) cloud description -- have children use their own words to describe the size, shape, and color.

4. Demonstrate the uneven heating of the earth's surface. Using an earth-sun model from the science room, show: (a) that the sun's rays strike the earth more directly at the equator than at the poles; (b) that in the summer the sun's rays strike the northern hemisphere more directly than they do in the winter; (c) that in the summer any place in the northern hemisphere is on the daylight side of the earth more than half of the 24 hours of the day. In the winter, the opposite is true.

5. Observe a barometer and record any changes in air pressure.

6. Stretch a piece of rubber balloon over the mouth of a bottle, and tie it securely. With glue, fasten a straw to the center of the rubber. Arrange the bottle and straw so that it points to a lined piece of paper fastened to the wall or chalkboard. Record changes throughout several days.

7. Cut two rubber balls into halves and nail them to the ends of two crossed sticks. Stick a nail through the point where the sticks cross. Mount this on a simple wooden stand. This is a wind speed indicator.

8. Construct a simple weather vane (cardboard or wooden arrow, a nail, a wooden stand).

9. A simple rain gauge can be made by setting an old ruler upright in a tin can.

Evaluation Sample
Grade 5
Unit: Weather and Seasons

Evaluation of the unit is done by researched material, drawings, and records of findings from experiments that students are to complete and keep in their own notebooks.

Included also is the following test.

Science Test -- Weather and Seasons Unit

Select the best answer to complete each statement. Write the letter of the answer in the space at the left.

1. ____ The layer of the atmosphere in which our weather takes place is the a. stratosphere b. ionosphere c. troposphere.

2. ____ Atmospheric pressure is measured by a. anemometers b. barometers c. hygrometers.

3. ____ Cold air a. is less dense than warm air b. is more dense than warm air c. has the same density as warm air.

4. ____ Cirrus clouds a. are thin and curly b. are light and puffy c. look like gray sheets.

5. ____ Relative humidity is measured by a a. barometer b. hygrometer c. anemometer.

6. ____ About 10 inches of snow is equal to the amount of water in a. 10 inches of rain b. 1 inch of rain c. 5 inches of rain.

7. ____ The falling of rain or snow is called a. precipitation b. visibility c. relative humidity.

8. ____ When a warm air mass takes the place of a cold air mass, a a. cold front occurs b. stationary front occurs c. warm front occurs.

9. ____ Winds are caused a. by moving air b. by warm and cold air "bumping" together c. by changes in air temperature.

10. ____ When water evaporates, a. it changes from a gas to a liquid b. it changes from a liquid to a gas.

11. ____ When water condenses, a. it changes from a gas to a liquid b. it changes from a liquid to a gas.

12. ____ To measure the temperature of the air, we need a a. hygrometer b. thermometer c. barometer.

Evaluation Sample (Cont.)
Grade 5
Unit: Weather and Seasons

Questions to Research

1. Explain the difference between weather and climate.
2. Draw a diagram of the water cycle.
3. List the types of precipitation.
4. What is wind?
5. What instrument is used to determine wind speed? How?
6. Winds of the earth would blow directly north and south. Something causes them to go diagonally. What is it?
7. What is meant by a "front?" Explain the difference between a warm front and a cold front.
8. What is the importance of air pressure and what instrument is used to measure it?
9. Draw and label four types of clouds.
10. What can we tell about the weather from each cloud type?
11. What is meant by relative humidity?
12. Choose three experiments found in card box in weather center. Record your findings.

Unit Outline
Grade 5
Unit: Light and Optics

I. Mirrors and Light

- A. Finding different ways of shining light beams on screens
- B. Using probe sticks to cast shadows
- C. Directing reflections to predetermined points

II. Colors and Light

- A. Crossing and mixing red, blue, and green light beams
- B. Using probe sticks to produce colored shadows
- C. Making double drawings

III. Refraction of Light

- A. Observing light passed through container of water
- B. Using combs and water to form colored bands
- C. Using prisms and lenses to bend light rays
- D. Observing changes of direction when light rays pass through salt or sugar solutions

OBJECTIVE: To observe and explore aspects of reflection and some of the properties of shadows

TITLE: "Mirror and Shadows"

SOURCE: *Optics*. ESS Teacher's Guide and kit

OBJECTIVE: To explore the makeup of "white" light and to understand that colors result from different wave lengths of light

TITLE: "A Rainbow of Color"

SOURCE: *Optics*. ESS Teacher's Guide and kit
The World Book Encyclopedia

OBJECTIVE: To show that light rays bend or are refracted as the light speed varies according to the medium through which they pass

TITLE: "Bending the Ray"

SOURCE: *Optics*. ESS Teacher's Guide and kit

Resources
Grade 5
Unit: Light and Optics

Text Materials

Concepts and Challenges in Physical Science, Book 1. Cebco Standard Publishing.

Gateways to Science. McGraw-Hill Book Company, 1979.

Optics. ESS Teacher's Guide.

Science, Understanding Your Environment. Silver Burdett, 1978.

SPIES: Light and Sound. Silver Burdett, 1976.

SPIES: Skill Builders. Silver Burdett, 1976.

Films -- Grandview Heights Public Library

Learning About Light

A Light Beam Named Ray

Filmstrips -- school library

Bounding and Bending Light

Light and Eyes

Light Is Refracted. Doubleday.

Transparencies

Light. Transparency book, elementary science rooms.

Kits

ESS materials kit for Optics
Prisms and lenses

Exemplary Activity
Grade 5
Unit: Light and Optics

OBJECTIVE: To learn the meaning of reflection and to understand basic aspects of reflection

MATERIALS AND EQUIPMENT: Light sources, mirrors, holders, tape

PROCEDURE:

See Teacher's Guide for Optics for instruction on setting up the classroom. Allow some time for free exploration. Distribute sheets with the following suggested activities.

1. Use several mirrors and reflect or "pass" the light from one to another. What happens to the light?
2. Set up several mirrors so that a light beam travels from one to the other and hits a screen. How can you prove that it is your light beam striking the screen?
3. Mark a spot on a screen. Can you set up your mirrors so that the light beam will hit right on the mark?
4. Make a mark on the floor with a piece of tape. Can you set up your mirrors so that two or three beams will cross at exactly that spot?

Follow up the activity by asking the group a series of questions. Keep a brief record of the responses.

Example questions:

1. What happened to the light when it struck the mirror?
2. Could you tell what kind of angle was formed when the light struck the mirror?
3. Did increasing the number of mirrors and number of times the light was reflected affect its intensity?

OBJECTIVE: To explore the makeup of white light

MATERIALS AND EQUIPMENT: From ESS kit Optics, light sources, mirrors and holders, screens, #4 and #5 masks, probe sticks, white paper, and coloring materials

PROCEDURE:

Use the #4 masks to filter the white light coming from the bulb so that three beams colored red, blue, and green are created.

Use mirrors to make the red, blue, and green beams cross and mix, either on the floor or on a screen. Keep a record of the colors formed.

Use probe sticks to produce colored shadows on the screen or floor.

Use the probe sticks and make shadows that are one part red and one part green.

Use the #4 or #5 masks to cover the slots in the light source. Use the crayons and white paper to make some small pictures that can be observed when held under the colored light. This may be extended to "double drawings." Example: A house with open windows when observed in green light may be a house with no windows when observed in red light.

OBJECTIVE: To observe light rays as they pass through various mediums in order to comprehend the meaning of refraction

MATERIALS AND EQUIPMENT: From ESS kit Optics, light sources, containers, water, #1 and #4 masks, probe sticks, sugar, combs

PROCEDURE:

Use a light source and a #4 mask to show that light travels in straight lines.

Shine the beams into an empty container.

Shine the beams through a container of water.

Use the #1 masks and containers of water. Students may move containers into light beams and observe that the light sometimes bends or changes directions.

Use the combs to cast shadows and turn wide beams into many narrow ones. Hold one comb between the container and the source and another comb on the other side of the container to observe colored bands.

Dissolve sugar (or salt) in a container of water. Compare the light rays entering and leaving a container of plain water to the beams entering and leaving the solution.

Evaluation Sample
Grade 5
Unit: Light and Optics

Sometimes giving children an opportunity to tell what they know in their own way can be revealing.

In order to ensure your receiving insight into the child's understanding of the three main areas of light that have been studied (reflection, color, refraction), use the mainheads of the outline provided at the beginning of this unit as titles and ask the children to write what they understand about each.

Also, it is a good idea to ask the children to write at least three questions they have about light. This may promote further study and it should reveal the depth of interest in the study, which is another facet of evaluation.

Unit Outline
Grade 5
Unit: Gases and Air

Description of Unit: The unit involves a series of closely linked laboratory experiments investigating the nature of air and the changes it undergoes when interacting with common objects in our environment. Students undertake investigations with the gases of the atmosphere (air) and the "things" of the universe (rock, iron, water, seeds, a candle).

I. Activities or Phenomena That Demonstrate That Air Is Real

   A. Wind blows leaves around
   B. Stars shine at night
   C. Kites fly
   D. Earthquakes shake the ground

II. Procedures for Transferring Gases From One Container to Another

   A. Invert a tube of water on a tray -- water is retained in the tube.
   B. Use a syringe to remove all the air from an inverted tube.

III. Understanding of the Results of "Candleair" Investigations -- A Burning Candle in a Closed Atmosphere Uses Up All the Oxygen.

IV. Investigate Multiple Causes for the Rise of Water Height in the Candle Tube During a Burning Candle Experiment.

Suggested Activities
Grade 5
Unit: Gases and Air

OBJECTIVE: To show that air is real and occupies space

TITLE: "Air Is a Real Substance"

SOURCE: The New Air Book. Thomas Crowell Company, 1974.

OBJECTIVE: To show that air expands when heated

TITLE: "The Burning Candle Experiment"

SOURCE: Gases and Air, ESS Teacher's Guide, pp. 99-103.

OBJECTIVE: To demonstrate the effect of heating the air in an open container and then closing off the container

TITLE: "The Egg and the Bottle"

SOURCE: Gases and Air, ESS Teacher's Guide, pp. 129-130.

Resources
Grade 5
Unit: Gases and Air

Text Materials

Concepts and Challenges in Physical Science, Book 1. Cebco Standard Publishing.

Frisky. The True Book of Air Around Us. Children's Press.

Gases and Air. ESS Teacher's Guide and student worksheets.

Gateways to Science. McGraw Hill, 1979.

Knight. The First Book of Air.

The New Air Book. Thomas Crowell, 1974.

Pine and Levine. Air All Around Us.

Rosenfeld. Science Experiments With Water. Chapter 17, pp. 149-158.

Science, Understanding Your Environment. Silver Burdett, 1978.

SPIES: Ecology. Silver Burdett, 1976.

SPIES: Skill Builders. Silver Burdett, 1976.

Filmstrips — Available from school libraries

Air and Its Properties

Air Around Us

Air Helps Things to Float in Water

Air Is Everywhere

Air Is Real

Air Pushes Against Things

Floating and Moving on Water

How Does Water Get Into Air

Living Things Need Air

Water and Its Work

What Is Wind?

Filmstrips (Cont.)

What Makes Things Dry Faster

Why Things Float

Kits

ESS materials kit for Gases and Air

Exemplary Activity
Grade 5
Unit: Gases and Air

OBJECTIVE: To demonstrate that air is a real substance

MATERIALS AND EQUIPMENT: Glass tumbler, large glass jar, cork

PROCEDURE:

1. Partly fill the large glass jar with water.
2. Place the cork on the surface of the water.
3. Invert the glass tumbler and, placing it over the cork, force it down into the water. (The cork stays even with the rim of the glass.)

   Explanation: Air is a real substance and occupies space. The glass tumbler is full of air and no water can enter it unless some of the air is removed.

OBJECTIVE: To demonstrate the effect of air on a burning candle

MATERIALS AND EQUIPMENT: Candles, matches, oil-base clay, 1 large plastic tube (without cap), 3" square of rubber sheeting

PROCEDURE:

1. Flatten out the clay and fix a birthday candle to it in an upright position.
2. Light the candle and put the tube over it, sealing the end tightly in the clay.
3. Then quickly stretch a piece of rubber sheeting tightly over the top of the tube so that this end is also sealed off. The flame will be extinguished and the rubber sheeting partly pushed into the tube.

OBJECTIVE: To demonstrate the effect of air pressure on a partial vacuum

MATERIALS AND EQUIPMENT: 1/2 gallon milk bottle, 1 hard-boiled egg (with the shell removed) that will fit in the mouth of the bottle without falling into the bottle, piece of paper, matches

PROCEDURE:

The piece of paper is ignited and dropped into the milk bottle. The egg is placed over the mouth of the bottle as quickly as possible.

The bottle can be heated by some other method (setting it in front of a lamp and so on), and the egg placed on top of the bottle after heating.

The children can be told what you are going to do and asked what they think will happen, or the demonstration can be performed and the children asked to explain why they think it behaved as it did. Some combination of these two approaches could also be used effectively.

No matter what approach you care to use, you end up with an egg inside the bottle, which presents the problem of getting it out. You could cut the egg into pieces and take it out, or you could blow into the mouth of the bottle while holding it upside down, but each of these approaches introduces a new factor.

Evaluation Sample
Grade 5
Unit: Gases and Air

Several different types of evaluation tools would seem appropriate with this unit.

1. Students maintain a notebook and record experiment results and conclusions and other data relating to gases and air.

2. Construct a teacher-made test that will examine the student's understanding of factual material and theories covered in the unit.

3. Make use of other evaluation methods such as teacher observation, written research reports, and oral reports presented to the class.

Unit Outline
Grade 5
Unit: Water Flow

Description of Unit: Students will build their own water systems from plastic tubing, water bottles, and other common materials. The students will learn how to control the flow of water and to predict its behavior under various circumstances. A teacher's guide and activity cards are provided with the Water Flow kit and are available to fifth grade teachers in each elementary school.

I. Water Flow Systems Can Be Assembled in Many Ways Using a Variety of Materials.

II. Water Volume and Air Pressure Affect a Water Flow System.

    A. Siphoning
    B. Blowing
    C. Raising
    D. Lowering

III. Water Flow Can Be Controlled and Changed Under a Variety of Conditions.

Suggested Activities
Grade 5
Unit: Water Flow

OBJECTIVE: To observe that water can be transferred from one container to another without pouring or tipping due to the changes in water and air pressure

TITLE: "Make a Siphon"

SOURCE: ESS Idea Card G7

OBJECTIVE: To see how water can be stored and released by man

TITLE: "Build a Dam"

SOURCE: Science in Our World. Heath and Company, p. 318.

OBJECTIVE: To see the relationship between air and water pressure

TITLE: "Cartesian Diver"

SOURCE: ESS Teacher's Guide, p. 54.

Resources
Grade 5
Unit: Water Flow

Text Materials

Concepts and Challenges in Physical Science, Book 1. Cebco Standard Publishing.

Gateways to Science. McGraw-Hill, 1979.

Inquiring Into Science. American Book Co., 1965, pp. 87-90, 92.

Science in Our World. Heath and Co., 1968, pp. 309-329.

Science, Understanding Your Environment. Silver Burdett, 1978.

SPIES: Ecology. Silver Burdett, 1976.

SPIES: Skill Builders. Silver Burdett, 1976.

Water Flow. ESS Teacher's Guide and Idea Cards X, G, S.

Related ESS teacher's guides, available in building science rooms:
- Clay Boats
- Drops, Streams and Containers
- Sink or Float
- Stream Tables

Films -- Grandview Heights Public Library

Problems of Conservation: Our Natural Resources, 11 min.

A Stream Environment, 9 min.

Filmstrips

Filmstrips related to conservation and properties of water are available from school libraries.

Transparencies

Ecology. Milliken transparency book. Available in science room at each elementary building.

Kits

ESS materials kit for Water Flow

Exemplary Activity
Grade 5
Unit: Water Flow

OBJECTIVE: To demonstrate an understanding of air and water pressure relationships

MATERIALS AND EQUIPMENT: Refer to ESS Teacher's Guide, Water Flow, p. 54.

PROCEDURE:

This is an extension activity, so it is probably best done toward the end of the unit.

Partly fill a medicine dropper with colored water. Place it in a stiff plastic tube that is filled to within 1" of the top and closed with fitted caps.

Press down on one cap very hard and the pressure on the water surface will increase. The air inside the "diver" (medicine dropper) takes up less space and allows water to enter the diver. With the additional water, the diver becomes heavier and sinks.

Release the pressure and the diver will expand, push out water, and rise again.

*All necessary materials are available in the Water Flow kit.

Evaluation Sample
Grade 5
Unit: Water Flow

1. Students will observe and record what they see. Each student should maintain a journal or notebook.
2. Students will find answers to their own questions through inventive means. This skill can be evaluated through oral questioning or through class reports.
3. Students will be able to predict changes in water flow systems due to various changes of conditions.

Unit Outline
Grade 5
Unit: Aviation and
Aerodynamics

Description of Unit: Study of aviation provides students with first-hand information concerning the "Air Age" in which we live. Principles of flying, types of aircraft, and some instruments used help provide an understanding. How aircraft have changed our lives, how they are made safe, how pilots' licenses are issued (qualifications), and how air travel is controlled are important areas of study involving many different skills, appreciations, attitudes, and much knowledge.

I. Bernoulli's Law

   A. Lift
   B. Drag
   C. Stall

II. Special Structures of Aircraft

   A. Wings provide lift to overcome gravity
   B. Engine -- push and/or pull aircraft through air
   C. Stability of aircraft -- vertical fin
   D. Course altered by movement of hinged surfaces

III. Instruments Important to Aircraft

   A. Altimeter -- altitude
   B. Magnetic compass -- direction
   C. Airspeed indicator
   D. Auto-pilot -- rests pilots on long flights

IV. Air Navigation

   A. Landmarks
   B. Dead reckoning -- directions, speed, time
   C. Celestial
   D. Radio

V. Purposes of Aircraft

   A. Transportation
   B. Recreation
   C. Crop dusting
   D. Mail delivery
   E. Observation and emergencies
   F. Military

VI. History of Aviation

VII. How Weather Affects Flying

  A. Air currents
  B. Storms
  C. Closed airports

VIII. How Flying Has Changed Society

OBJECTIVE: To show how pressure affects aircraft and the importance of knowing height from ground level

TITLE: "Making an Altimeter That Measures Air Pressure"

SOURCE: Science in Our World, Book 5, "Earth and Space Navigations," p. 64.

OBJECTIVE: To show how air currents affect lighter than air craft (glider and hang gliding)

TITLE: "Making a Paper Airplane"

SOURCE: The Great International Paper Airplane Book. Simon and Schuster.

OBJECTIVE: To learn how air currents affect balloon flights

TITLE: "Balloon Flying"

SOURCE: Teacher

Resources
Grade 5
Unit: Aviation and
Aerodynamics

Text Materials

Gateways to Science. McGraw-Hill, 1979.

The Great International Paper Airplane Book. Simon and Schuster.

How Airplanes Fly. The John Day Company, 1971.

The New Air Book. Thomas Crowell Company, 1974.

Science for You, Book 6, "Men Learn to Leave Earth." Ginn and Co.

Science in Our World, Book 5, "Earth and Space Navigation." D.C. Heath.

Science Is Adventuring, Book 6, "How Have We Learned to Travel Through Air and Space." Scott-Foresman.

Science, Understanding Your Environment. Silver Burdett, 1978.

Films -- Grandview Heights Public Library

Airport: Gateway to the Skies, 11 min.

The Community Airport, 11 min.

International Airline: Wings Around the World, 13 min.

Filmstrips

Various filmstrips relating to aviation, air, weather, and atmosphere are available from school libraries and IRC.

Transparencies -- available from science room in each building

Transparency books, Air and Weather and Space Flight.

Field Trips

Don Scott Field
COSI
Columbus International Airport

Resource File

Parents (private pilots, glider or engine)

Exemplary Activity
Grade 5
Unit: Aviation and
Aerodynamics

OBJECTIVE: To study the effects of air currents on lighter than air craft (balloon travel)

MATERIALS AND EQUIPMENT: Balloons, strings, postcards, tank of helium gas, map of Midwest, pins, colored string, stamps

PROCEDURE:

Write on postcards, detailing your experiment. Give name and school address. Punch hole in card and attach to string. Fill balloon with helium. Tie with string attached to postcard.

Set adrift on playground. (Advise Columbus International Airport and Don Scott Field of project date and time.)

If and when postcards are returned by those who found them, plot on map of Midwest with pins. Stretch string from Columbus to pin placement. If enough are returned, good idea of air currents will be obtained.

OBJECTIVE: To make children aware of the dynamics involved in heavier than air flight and to provide hands-on experiences in understanding these concepts

MATERIALS AND EQUIPMENT: The Great International Paper Airplane Book and various types and sizes of paper: 8 1/2 x 11, 8 1/2 x 16, magazine sheets, newspaper

PROCEDURE: "The Old Paper Airplane Trick"

Tear the perforated design sheets from the airplane book and let children work independently in constructing several of these paper airplanes. Students should also be encouraged to design and construct their own airplanes. Have a paper airplane contest and give some type of award for the following categories:

1. Duration aloft (number of seconds in flight)
2. Distance
3. Stunt (loops, curves, height)
4. Smoothest landing

Rules

This activity will produce a high degree of excitement among the children and things will run more smoothly if certain rules are enforced.

A. The contest can take place in the classroom but may work better if done outside or in the gymnasium.

B. Students will line up and throw their airplanes one at a time. Airplanes should not be retrieved until everyone has thrown their plane. Airplanes should have student's name printed on the wing.

C. At the conclusion of the contest, all airplanes should be placed in wastebasket for disposal. If a student wishes to take his/her airplane home, it should be kept someplace for safekeeping and should not be discarded on the playground or in the neighborhood.

Evaluation Sample
Grade 5
Unit: Aviation and
Aerodynamics

I. Room Science Fair

Each student may choose an experiment and/or self-explanatory presentation to illustrate some principle of flight or any scientific principle involved or closely associated with flight.

The success of the presentation is subjectively evaluated by a team of three teachers who should give at least a one-sentence statement of success.

II. Teacher-Made Test

A teacher-made test may be constructed that will evaluate the student's understanding of aerodynamic principles that have been covered in the unit.

Unit Outline
Grade 6
Unit: Outdoor Education

Description of Unit: The unit relating to outdoor education should be very broad in scope and relate primarily to ideas and facts that are found in the out-of-doors. The study of this unit should precede the students' Resident Outdoor Education experience at Camp Otyokwa and continue with post-camp studies. The following information will relate to one area of study that can be included in the unit. The teacher should refer to the section on Resources for additional studies that may be included within the outdoor education unit. An excellent unit text has been selected to be used primarily with this unit. The book is titled A Walk in the Forest, and thirty copies of the book are available in each elementary building for sixth grade teachers.

I. Collection and Observation of Twigs

   A. Observe in natural environment.
   B. Take cuttings and sketch the tree or shrub from which they came.

II. Twig and Bud Development

   A. Compare the development of twigs from different trees.
   B. Become aware of reasons for variations.

III. Identification and Classification of Twigs

   A. Classify the twigs and buds based upon observed properties.
   B. Dissect the twig to identify layers and rings.

IV. Water Conduction of Twigs

   A. Identify how water is carried to the buds.
   B. Observe effect on buds when twigs are placed in water.

Suggested Activities
Grade 6
Unit: Outdoor Education

OBJECTIVE: To arouse student interest in twigs and to sharpen student powers of observation

TITLE: "Collection and Observation of Twigs"

SOURCE: Budding Twigs, ESS teacher's guide, pp. 7-9

OBJECTIVE: To observe and record the differences in the development of the twig indoors compared to outdoors

TITLE: "Variations in Twig Development"

SOURCE: Budding Twigs, ESS list of unit objectives

OBJECTIVE: To describe and identify layers and rings in a dissected twig section

TITLE: "Dissection of Twigs"

SOURCE: Budding Twigs, ESS list of unit objectives, teacher's manual, pp. 9-12

OBJECTIVE: To identify how water is carried to the buds

TITLE: "Water Conduction in Twigs"

SOURCE: Budding Twigs, ESS teacher's manual, pp. 19-20

OBJECTIVE: To develop student awareness and influence student values concerning living things and the environment

TITLE: "A Walk in the Woods"

SOURCE: Teacher developed activity to be conducted at the Upper Arlington Schools' Land Laboratory

Resources
Grade 6
Unit: Outdoor Education

Text Materials

Black Holes, White Dwarfs, and Superstars. Thomas Crowell, 1976.

Budding Twigs. ESS Teacher's Guide.

Concepts and Challenges in Earth Science, Book 3. Cebco.

Exploring Science. Laidlaw Brothers, 1979.

Gateways to Science. McGraw-Hill, 1979.

A Walk in the Forest. Thomas Crowell, 1977.

Related ESS teacher's guides and kits, available in science room:
- Animals in the Classroom
- Crayfish
- Earthworms
- Eggs and Tadpoles
- Pond Water

Films -- Grandview Heights Public Library

Seasonal Changes in Trees

Transparencies

Ecology, Reptiles, and Plants and Animals. Milliken transparency books available from science room in each elementary building.

Kits and Materials

ESS materials kit for Bones
Silva compasses
Outdoor Biology Instructional Strategies (OBIS) -- Sets I, II, III and IV
Microprojector from science room

Exemplary Activity
Grade 6
Unit: Outdoor Education

OBJECTIVE: To describe and identify layers and rings in a dissected twig section

MATERIALS AND EQUIPMENT: Twigs with buds for each child, paper, pencil, scissors, tweezers

PROCEDURE:

The children will be given a twig and asked, "What could you do to learn more about the twig?" They will then discuss the various ways of finding out about the internal structure of the twig by dissecting and peeling it.

Students can then investigate the internal structure in whatever manner they choose and record their findings. Some children will probably cut a cross-section to examine while others may peel each layer.

After a sufficient amount of investigating and recording time has been given, the students should discuss their findings. Questions that may be discussed are:

1. Are the insides of the stem similar in all twigs?

2. What are the similarities?

3. What are the differences?

4. Does the inside structure affect how long the twig stays "alive?"

5. How do cut surfaces of the cross-section differ?

The students may then try to identify the trees from which the twigs were taken by using a Key for Budding Twigs that can be obtained from the science consultant.

Evaluation Sample
Grade 6
Unit: Outdoor Education

The best form of evaluation would be teacher observation and written reports required of each student. Some teachers will prefer to construct an examination that will test the students' understanding of concepts studied in the unit.

Unit Outline
Grade 6
Unit: Oceanography

I. Importance of the Ocean
   A. Transportation
   B. Recreation
   C. Food
   D. Weather prediction
   E. Future uses

II. History of the Ocean
   A. Origin of the water in the oceans
   B. Prehistoric life and conditions
   C. Changes -- past and present

III. Ocean Features
   A. Trenches
   B. Atolls
   C. Continental shelf and slope
   D. Guyots
   E. Abyssal plains
   F. Mid-ocean ridge

IV. Marine Life
   A. Various fish species
   B. Mammals
   C. Plants

V. Oceanographic Tools
   A. Depth recorder
   B. Piston corer
   C. Nansen Bottle
   D. Bathyscaphe
   E. Sea Lab

Suggested Activities
Grade 6
Unit: Oceanography

OBJECTIVE: To identify ocean features and build understanding of characteristics, causes, and location of each feature

TITLE: "Exploring Ocean Features"

SOURCE: Man and the Ocean. Nystrom Kit. Use ocean features model and cassette tape.

OBJECTIVE: To describe the variety of life found on a beach or about a coral reef

TITLE: "An Investigation of Marine Life"

SOURCE: Man and the Ocean. Nystrom Kit. Use study prints from Unit 6.

OBJECTIVE: To discover direct and inverse ratios in ocean characteristics; to graph relationships of distance, time, and temperature observed in ocean studies

TITLE: "Math and the Ocean"

SOURCE: Man and the Ocean, Teacher's Guide

OBJECTIVE: To determine patterns in making sails for early sailing ships; to show these on a mural

TITLE: "Sailing, Sailing"

SOURCE: Man and the Ocean, Teacher's Guide

OBJECTIVE: To investigate the weight of objects in and out of water and compare results

TITLE: "Weight and Water"

SOURCE: Thinking Ahead in Science. American Book Co.

OBJECTIVE: To discover what effect temperature has on ocean currents

TITLE: "Temperature and Ocean Currents"

SOURCE: Thinking Ahead in Science, "The Ocean." American Book Co.

Resources
Grade 6
Unit: Oceanography

Text Materials

Exploring Science, Red Book. Laidlaw Brothers, 1979.

Gateways to Science. McGraw-Hill, 1979.

Jacobson, Lauby, and Konicek. *Thinking Ahead in Science*. American Book Co., 1965, pp. 178-240.

Oxenhorn, Joseph M., and Goldfeld, Burton I. *Oceanography and Our Future*. Globe Book Co., 1975.

SPIES: Ocean/Space. Silver Burdett, 1976.

Films -- Grandview Heights Public Library

Coral Wonderland, 20 min.

Life in the Ocean, 16 min.

Mysteries of the Deep, 24 min.

Seal Island, 27 min.

Whales -- Part I and II, 53 min.

Filmstrips -- All from the Nystrom Kit, *Man and the Ocean*. Available from science room.

The Biological Environment

Man Uses the Ocean

The Ocean and the World Ecosystem

The Ocean Frontier

The Physical Environment

Transparencies

Oceanography. Milliken Publishing Co. Available from science room.

Kits

A complete oceanography kit including landform maps and globes, filmstrips, cassettes, ditto masters, and student worksheets

Exemplary Activity
Grade 6
Unit: Oceanography

OBJECTIVE: To discover what effect temperature has on ocean currents

MATERIALS AND EQUIPMENT: Two one-quart milk bottles, cold and hot water, food coloring, 3 x 5 index card

PROCEDURE:

Fill one bottle with cold water and one bottle with hot water.

Color the hot water with food coloring and allow the color to spread evenly throughout the water.

Take the 3 x 5 card and hold it tightly over the top of the bottle of cold water.

Carefully turn the bottle upside down and place it on top of the bottle containing colored hot water. Be sure the mouths of the bottles are directly over each other.

Slowly remove the card and watch the movement of the water in each bottle. Is the water in both bottles moving? In which direction does the colored water flow?

Reverse the experiment. Follow same procedure, except this time put the bottle containing hot water on top. Does the hot water replace the cold water?

Scientists believe that the intense heating of the ocean waters in the Gulf of Mexico causes the Gulf Stream. Cold water from the north forces warm water upward and northward in the Gulf Stream.

This activity was taken from Thinking Ahead in Science. American Book Co., p. 215.

Evaluation Sample
Grade 6
Unit: Oceanography

The following teacher-made test is an excellent way to evaluate the students' understanding of facts and concepts presented in the unit.

Oceanography Test

Name ________________________

True-False

1. _____ An ocean is larger than a sea.
2. _____ One of the major minerals found in the ocean water is sodium chloride (table salt).
3. _____ The largest plants in the ocean are the giant kelp.
4. _____ Water pressure increases with increasing depth.
5. _____ The ocean floor is all smooth and flat.
6. _____ Microscopic ocean plant and animal organisms are known as plankton.
7. _____ Fish are the only thing we take from the ocean.
8. _____ The temperature of ocean water at great depths is very warm.
9. _____ We can use the ocean to predict weather.
10. _____ The continental shelf is in the middle of each major ocean.

Matching

1. _____ nansen cask
2. _____ sonar
3. _____ white cap
4. _____ abyssal plain
5. _____ piston corer
6. _____ mid-Atlantic ridge
7. _____ octopus
8. _____ Pacific Ocean

A. flat-topped volcanoes in the ocean
B. a creek that runs into the Scioto River
C. wave with a pushed-off crest
D. the largest ocean
E. used to bring up samples of bottom of ocean
F. takes water samples at different depths
G. sea creature with eight tentacles
H. smooth area of the ocean floor

Evaluation Sample (Cont.)
Grade 6
Unit: Oceanography

Matching (Cont.)

9. _____ guyots

10. _____ desalination

I. the largest ocean

J. tool used to indicate depths of the ocean

K. changing salt water to fresh water

L. vast underwater mountain chain

Fill in the blanks.

1. One of America's oceanographic ships is called ______________________.

2. The ocean floor contains deep cracks called _________________________.

3. Friction between water and wind causes ________________.

4. To capture different species of animals at different depths, a tool called a ________________________ is used by oceanographers.

5. Nearly ______________ of the earth's surface is covered with water.

6. Two land formations on the earth that are similar to ocean features are ____________________ and ____________________.

7. Two kinds of scientists you might find aboard a research ship are ___________________ and __________________.

8. __________________ are microscopic organisms that float around in the water.

In at least 3 sentences explain one of the ways man uses the ocean.

In at least 3 sentences describe one of your favorite sea animals you have studied.

Where do scientists believe the ocean water originally came from?

Unit Outline
Grade 6
Unit: Astronomy -- Beyond
the Solar System

I. How the Universe Is Studied

- A. Refracting and reflecting telescopes
- B. Radio telescopes
- C. Spectroscopes

II. Mapping the Sky With Constellations

- A. Circumpolar constellations
- B. Constellations of winter, spring, summer, and autumn
- C. Using a star chart

III. Stars of the Universe

- A. Numbers of stars
- B. Distance of stars
- C. Brightness of stars
- D. Classification of stars
- E. Star types
- F. Galaxies

IV. History of Beliefs About the Universe

- A. Ideas of early man
- B. Mythology reflected in the universe
- C. Astrology
- D. Men who molded ideas
    1. Aristotle
    2. Ptolemy
    3. Galileo
    4. Copernicus
    5. Kepler
    6. Newton
    7. Einstein

Suggested Activities
Grade 6
Unit: Astronomy -- Beyond
the Solar System

OBJECTIVE: To visualize and understand rotation of the star map by placement of circumpolar constellations on inside of black umbrella

TITLE: "The Sky-Bowl as a Twirling Umbrella"

SOURCE: Johnson and Adler. Discover the Stars. Sentinel Book Publishers, Inc., 1962.

OBJECTIVE: To show the ecliptic and the equator by means of a round chemist's flask half filled with inky liquid

TITLE: "Planetarium in a Bottle"

SOURCE: Johnson and Adler. Discover the Stars. Sentinel Book Publishers, Inc., 1962.

OBJECTIVE: To determine the latitude of stars, UFO's, planets, and other heavenly apparitions

TITLE: "UFO Finder or Clinometer"

SOURCE: Johnson and Adler. Discover the Stars. Sentinel Book Publishers, Inc., 1962.
Science for Tomorrow. 6th grade text.
COSI

OBJECTIVE: To show how heat can change color of wire or nail as temperature increases

TITLE: "Stars Differ in Color"

SOURCE: Victor, Edward. Science for the Elementary School.

OBJECTIVE: To show how light rays are distorted by passing through a heated field

TITLE: "Twinkle, Twinkle Little Star"

SOURCE: Victor, Edward. Science for the Elementary School.

OBJECTIVE: To demonstrate what happens when light rays strike a curved surface; to demonstrate what happens when dust particles are introduced into the field

TITLE: "Light Rays Reflected by Curved Surface"

SOURCE: Investigating in Science. Grade 6 text. American Book Co.

OBJECTIVE: To demonstrate by simple constructions the principles of the two types of optical telescopes

TITLE: "Reflecting and Refracting Telescopes"

SOURCE: Investigating in Science. Grade 6 text. American Book Co.

OBJECTIVE: To show how light from a star is studied by using a prism to reflect sunlight onto a piece of paper; to observe the sunlight separated into colors

TITLE: "Break a Sunbeam"

SOURCE: Teacher developed

OBJECTIVE: To use a star chart to construct a star wheel so that those stars visible at a given time of month are those visible on the chart

TITLE: "Mount a Star Chart"

SOURCE: How and Why Wonder Book of Stars. Grosset and Dunlap, 1974.

Additional Activities

1. A star party at Camp Otyokwa or on a moonless night in Upper Arlington
2. A trip to the COSI planetarium
3. A resource person who could bring in and explain a telescope as well as some of the attached mechanisms

4. The weekly astronomy column in the Columbus Dispatch (Sunday) along with other articles found in newspapers and periodicals could be kept in a scrapbook or on a bulletin board.

5. Make a labeled poster of the evolution of a star.

6. Make a chart of star magnitudes. Give examples where possible.

7. Make posters diagraming reflecting, refracting, and radio telescopes.

Resources
Grade 6
Unit: Astronomy -- Beyond
the Solar System

Text Materials

Black Holes, White Dwarfs, and Superstars. Thomas Crowell Company, 1976.

Concepts and Challenges in Earth Science, Book 3. Cebco Standard Publishing.

Concepts in Science, Grade 6. Harcourt, Brace, Jovanovich, Inc., 1972.

Exploring Science, Red Book. Laidlaw Brothers, 1979.

Gateways to Science. McGraw-Hill, 1979.

Investigating in Science, Grade 6. American Book Company, 1965.

Science for Tomorrow's World, Grade 6. Macmillan Science Series, 1966.

Science Is Adventuring, Grade 6. Scott, Foresman and Company, 1965.

SPIES: Ocean/Space. Silver Burdett, 1976.

Supplementary Reading Materials

Branley, Franklyn M. A Book of the Milk Way Galaxy. Crowell, 1965.

Gallant, Roy A. Exploring the Universe. Garden City Books, 1956.

Ivins, Ann. The Beginning Knowledge Book of Stars and Constellations. Macmillan, 1969.

Limburg, Peter R. What's in the Names of Stars and Constellations? Coward, McCann, and Geoghegan.

Menzel, David. A Field Guide to Stars and Planets. Houghton, 1964.

Ross, Norman. How and Why Wonder Book of Stars. Merrill, 1960.

Zim, Herbert S. and Baker, Robert H. Stars. Golden Press, 1956.

Films -- Grandview Heights Public Library

The Flaming Sky, 29 min.

Universe, 28 min.

The Universe -- Flight to the Stars, 21 min.

Unseen World, III -- Oceans of Space, 17 min.

Filmstrips

Various titles available from each school library

Transparencies

Outer Space. Milliken transparency book. Available from science room in each elementary building.

The Universe. Milliken transparency book. Available from science room in each elementary building.

Models and Materials

Solar system model
Planet rotation/revolution model
Student star charts

Exemplary Activity
Grade 6
Unit: Astronomy -- Beyond
the Solar System

OBJECTIVE: To recognize and locate northern constellations

MATERIALS AND EQUIPMENT: Overhead projector, black paper, projection screen, transparency frame

PROCEDURE:

Children are assigned a constellation that appears in the northern hemisphere. Research on their constellation should answer the following questions:

When does the constellation appear in the night sky?
How can the constellation be found in the sky?
What important or interesting stars are included in the constellation?
What mythology is associated with the constellation?

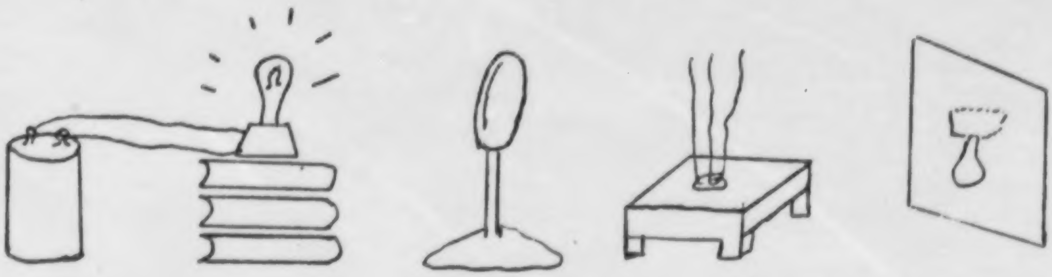
The children then use black construction paper and "punch out" their constellations. The paper is then placed on an overhead projector. The room should be darkened and a penlight used for a pointer as children give their oral reports for this indoor "star party."

Auxiliary charts and posters could be put up in the room detailing the use of "pointer" stars, naming of important stars, and descriptions in terms of magnitudes and types of stars. Drawings of what children believe the ancients saw when they named the constellations can be made, e.g., a drawing of the herdsman that the ancients called Bootes.

The best of culminating activities is to locate the constellation in the night sky whenever possible.

OBJECTIVE: To see some ways that the earth's atmosphere interferes with images of stars when using optical telescopes

MATERIALS AND EQUIPMENT: Flashlight bulb and holder, dry cell battery, magnifying glass, heat source (hot plate), movie screen



Exemplary Activity (Cont.)
Grade 6
Unit: Astronomy -- Beyond
the Solar System

PROCEDURE:

Set up light source, magnifier and screen as shown on previous page. Observe image on screen. Introduce heat source and observe image again. Bang together two erasers filled with dust. What happens?

Formulate solutions to problems caused by earth's atmosphere when using optical telescopes.

Evaluation Sample
Grade 6
Unit: Astronomy -- Beyond
the Solar System

1. Teacher-made quizzes
2. "In the Know" questions used in a game format; good after report series
3. Student demonstrates ability to locate specified objects in the night sky.
4. "Who Am I?" game at a star party or in classroom
5. The unit on astronomy can be made more interesting to the student if the teacher will incorporate such concepts as space flight and unidentified flying objects.
6. An evaluation example is a teacher-modified exercise based on "Spaceflight Quiz" by Norman F. Smith that appeared in The Science Teacher, January, 1971.

Unit Outline
Grade 6
Unit: Small Things and
Microgardening

Description of Unit: This unit is a combination of two Elementary Science Study (ESS) units that can complement each other when taught as a single unit. During the study of Small Things, students are introduced to the microscopic world, to the instruments needed to make it accessible, and to the differences in appearance and structure of living and nonliving things. The study of Microgardening will introduce students to the molds -- a group of microscopic living things very different from the growing things with which they are familiar. Students become familiar, through their own experimentation, with principles and procedures that have contributed to man's knowledge over the past 200 years.

I. Magnifying Devices

   A. Water-drop lens
   B. Hand lens
   C. Compound microscope

II. Preparation of Specimens and Slides

   A. Technique
   B. Cellular structure and theory

III. Microscopic Observations (Living Things)

   A. Mold
   B. Bacteria
   C. Yeasts
   D. Onion
   E. Protozoa
   F. Insects

IV. Microscopic Observations (Nonliving Things)

   A. Newspaper, magazine print
   B. Fabric samples
   C. Yarn, thread, string
   D. Feathers, hair

Suggested Activities
Grade 6
Unit: Small Things and
Microgardening

OBJECTIVE: To construct a water drop magnifier and describe small things viewed through this magnifier; to use a hand lens to view small things

TITLE: "Finding Out About Making Things Look Larger"

SOURCE: Small Things, ESS Teacher's Guide

OBJECTIVE: To demonstrate appropriate techniques in using a compound microscope

TITLE: "What Is a Compound Microscope?"

SOURCE: Small Things, ESS Teacher's Guide

OBJECTIVE: To demonstrate the preparation and use of a microscope slide

TITLE: "Preparing and Using a Microscope Slide"

SOURCE: Small Things, ESS Teacher's Guide

OBJECTIVE: To describe the properties of a cell, its parts, and its relationship to the larger organism

TITLE: "What Is a Cell?"

SOURCE: Small Things, ESS Teacher's Guide

OBJECTIVE: To grow bread molds and examine the details of mold structure

TITLE: "What Are Molds?"

SOURCE: Microgardening, ESS Teacher's Guide
Molds, Teacher's Manual (Tannenbaum)

OBJECTIVE: To recognize that spores found in the air are responsible for initiating mold growth

TITLE: "Where Do Molds Come From?"

SOURCE: Microgardening, ESS Teacher's Guide
Molds, Teacher's Manual (Tannenbaum)

OBJECTIVE: To define bacteria, identify some common types of bacteria by sight, and use sterile materials to encourage antibiotic action

TITLE: "Bacteria"

SOURCE: Microgardening, ESS Teacher's Guide
Instructor's Manual for Den-Test Kit, Kemtec Educational Corp.

OBJECTIVE: To identify yeasts by sight

TITLE: "Yeasts"

SOURCE: Microgardening, ESS Teacher's Guide

OBJECTIVE: To use a microscope to examine the cellular structure of an onion

TITLE: "A New Look at an Onion"

SOURCE: Small Things, ESS Teacher's Guide

OBJECTIVE: To learn to use stains, which help to make the parts of cells more clearly viewed; to learn that certain stains make it easier to see particular parts of cells

TITLE: "Using Stains to See More About Onion Cells"

SOURCE: Small Things, ESS Teacher's Guide

OBJECTIVE: To use a microscope to examine plant and animal life found in a drop of water taken from a pond or from a hay infusion

TITLE: "Life in a Drop of Pond Water"

SOURCE: *Small Things*, ESS Teacher's Guide

OBJECTIVE: To identify by sight the following protozoans: volvox, stentor, amoeba, rotifer, euglena, paramecium, planaria (miscellaneous)

TITLE: "Meet the Micro-Animals"

SOURCE: *Small Things*, ESS Teacher's Guide

OBJECTIVE: To use a microscope to examine specimens of common insects

TITLE: "Take a Closer Look at the Insects"

SOURCE: *The Microscope*. Activity cards published by Creative Teaching Press, Inc.

OBJECTIVE: To use a microscope to examine various kinds of paper, particularly noting the appearance of the ink on the paper

TITLE: "Look in the Funny Papers"

SOURCE: *The Microscope*. Activity cards published by Creative Teaching Press, Inc.

OBJECTIVE: To use a microscope to distinguish the differences in various fabric types

TITLE: "Watch What You Wear"

SOURCE: *The Microscope*. Activity cards published by Creative Teaching Press, Inc.

OBJECTIVE: To use a microscope to distinguish the structure of various thread, yarn, and string specimens

TITLE: "Thread, Yarn, and String"

SOURCE: The Microscope. Activity cards published by Creative Teaching Press, Inc.

OBJECTIVE: To use a microscope to examine the structure and color of feathers and hair

TITLE: "A Ticklish Experience"

SOURCE: The Microscope. Activity cards published by Creative Teaching Press, Inc.

Resources
Grade 6
Unit: Small Things and
Microgardening

Text Materials

Concepts and Challenges in Physical Science, Chemistry, Book 1. Cebco Standard Publishing.

Concepts in Science, 6th grade. Pp. 200-206.

Den-Test Kit, Instructor's Manual. Kemtec Educational Corp.

Exploring Science, Red Book. Laidlaw Brothers, 1979.

Fun With Chemistry. Random House, 1972.

Gateways to Science. McGraw-Hill, 1979.

Microgardening. ESS Teacher's Guide.

The Microscope. Activity cards published by Creative Teaching Press, Inc.

The Microscope and What You See. Ed. by Dr. Paul E. Blackwood. New York: Grossett and Dunlap.

Molds. Teacher's Manual. Tannenbaum.

Science for Today and Tomorrow, 6th grade. Pp. 47-54, 67.

Science Is Adventuring, 6th grade, Unit 8. Pp. 226-259.

Small Things. ESS Teacher's Guide and student worksheets.

SPIES: Matter, Matter Everywhere. Silver Burdett, 1976.

Films -- Grandview Heights Public Library

The Cell

Life in a Drop of Water

What's Alive

Study Prints

Small Things Study Prints, ESS

Kits and Materials

ESS materials kit for Small Things
ESS materials kit for Microgardening
Microscopes and microprojector

Exemplary Activity
Grade 6
Unit: Small Things and
Microgardening

OBJECTIVE: To use stains to see more about cells

MATERIALS AND EQUIPMENT: See teacher's guide for Small Things, pp. 41-45. The teacher should read pp. 41-43 very carefully to become familiar with the procedure, materials, and expected outcomes. This reading will also familiarize the teacher with necessary vocabulary.

PROCEDURE:

The teacher distributes materials and worksheets (pp. 44-45) to the students for silent reading. Students read to find:

a. What a stain is used for
b. Three kinds of stains we will use today

The teacher leads a discussion, drawing out the answers to the questions above and reviewing what the students have already learned about onion cells.

The teacher introduces the following terms: cell wall, nucleus. Discuss their function and location within the cell.

The teacher demonstrates the proper way to dissect the onion and stain the specimen. Then the students, working in groups of two's or three's, carefully dissect and stain their own specimens, following the steps outlined on their worksheets.

As mentioned on p. 43 in the teacher's guide, the students should find that eosin y stains all of the cell, except the nucleus, a light red. Methylene blue and Lugol's iodine stain the cell wall and nucleus darker than the rest of the cell.

Use a microprojector to project several students' specimens for the entire class to view. To provide closure, structure a review session, asking students to point out the cell nucleus and cell wall. Also ask students which kind of stain was used on the given specimen.

Evaluation Sample
Grade 6
Unit: Small Things and
Microgardening

The following is a teacher-made test that examines the students' understanding of facts and concepts that have been studied in the unit.

Name ______________________________ Date ______________

SCIENCE TEST: Small Things
Microgardening

I. True-False. Print T if the statement is true; print F of the statement is false.

_____ 1. All mold plants look alike.

_____ 2. Lugol's iodine is a stain that helps us to see the parts of a cell more clearly.

_____ 3. Anton van Leeuwenhoek discovered that penicillium mold kills harmful bacteria.

_____ 4. Mold plants release spores into the air; the spores develop into new plants upon landing on a sunny, dry surface.

_____ 5. Robert Hooke named the microscopic components of cork "cells" because their shape reminded him of the small chambers (cells) in which European monks lived.

_____ 6. An onion cell does not have a nucleus.

_____ 7. The mirror on a compound microscope can be adjusted to allow more light to reflect on the specimen.

_____ 8. If you find a spot of mold on a piece of cheese, you can slice off the moldy area; the rest of the cheese is safe to eat.

_____ 9. A cover slip is an important part of a compound microscope.

_____10. We can magnify an object by using a crayon, a glass slide, and a drop of water.

II. Fill in the blanks. Use the word list on the next page to complete the statements correctly.

1. The three main parts of an onion cell are the ______________, ______________, and ____________________.

2. The three kinds of stains we used were ____________________,

____________________, and ____________________.

3. Some microscopic animals have a ____________________________, which is a tail-like part of the animal.

4. ____________________ are hair-like fibers found on the stentor and the rotifer. These fibers are used by the animals to help take in food and to move about.

5. We place the specimen on this part of the microscope for viewing:

____________________.

6. A cluster of many mold plants growing close together is called a mold

____________________.

Word list for fill in the blanks:

- flagellum (flagella)
- Lugol's iodine
- colony
- nucleus
- stage
- eyepiece
- methylene blue
- cilia
- eosin y
- cell wall
- protoplasm
- paramecium

III. Identifying microscopic animals. Direct your attention to the chalkboard. There are drawings of four microscopic animals. Give the names of these animals in the spaces below.

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________

IV. The compound microscope. Label the parts of the compound microscope.

Unit Outline
Grade 6
Unit: Geology

I. The Earth Is Continually Changing

   A. The surface of the earth
   B. Looking inside the earth
   C. Factors that affect change
   D. Three major classes of rocks
      1. Igneous
      2. Metamorphic
      3. Sedimentary

II. The Earth Is Continually Building

   A. Volcanoes
      1. Process of volcanic activity
      2. Structure of typical volcano
      3. Three major types of volcanoes
         a. Quiet
         b. Intermediate
         c. Explosive
      4. Types of rocks that are associated with volcanoes -- igneous
   B. Earthquakes and slow earth movement
      1. Process of earth movement
      2. Kinds of earth movement
         a. Normal
         b. Reverse and strike slip
         c. Faults
      3. Rocks related to this process
         a. Igneous
         b. Metamorphic

III. The Earth Is Continually Wearing Away

   A. Water
      1. Running water -- the primary source of erosion
      2. Oceans, seas, and other large bodies of water
      3. Climate conditions
   B. Ice
      1. Freezing and thawing
      2. Mountain glaciers
      c. Continental glaciers and ice caps
   C. Wind
   D. Plants and plant succession
   E. Related rocks and soils
      1. Types of sedimentary rocks
      2. Gravel
      3. Sand and clay
      4. Land formations

Suggested Activities
Grade 6
Unit: Geology

OBJECTIVE: To become familiar with the limestone deposits and fossils that are prevalent in the Upper Arlington area. A good location for the trip would be the area north of Fishinger Road where a series of small cliffs runs parallel to the river. Many fossils can be found in these loose limestone deposits.

TITLE: "A Field Trip to the Scioto River"

SOURCE: Teacher. Identify fossils using resource books and pictures. Identify era of fossil formation using resource books. Make a mural of the Scioto Valley at the time of fossil formation, showing how fossils and the valley looked at that time. Display fossils in front of murals. Have each individual draw the original plant or animal and display it with fossil found.

OBJECTIVE: To understand how the earth's continents have moved and to trace the facts and logic that led scientists to discover that movement

TITLE: "A New Look at Spaceship Earth"

SOURCE: Teacher

OBJECTIVE: To enable the student to examine the basic structures of the earth and their interrelationships

TITLE: "Inside Spaceship Earth"

SOURCE: Teacher

OBJECTIVE: To introduce the concept of plate tectonics and to understand how this process is changing the face of the earth

TITLE: "On Spaceship Earth"

SOURCE: Teacher

Resources
Grade 6
Unit: Geology

Text Materials

"The Changing Earth," *National Geographic*, January 1973.

Concepts and Challenges in Earth Science, Book 3. Cebco Publishing Co.

"Continents Adrift" and "Continents Aground," *Scientific American*.

Dewey, John F. "Plate Tectonics," *Scientific American*, May 1972.

Deitz and Holden. "The Breakup of Pangea," *Scientific American*, October 1970.

Exploring Science, Red Book. Laidlaw Brothers, 1979.

Gateways to Science. McGraw-Hill, 1979.

Golden, Frederick. *The Moving Continents*.

Hallam, A. "Alfred Wegener and the Hypotheses of Continental Drift," *Scientific American*, February 1975.

Oxenhorn, Joseph M., and Goldfeld, Burton I. *Oceanography and Our Future*. Globe Book Co., 1975.

Schneider, Nina and Herman. *Science in Our World*, Book 5, 3rd ed. Boston: D.C. Heath and Co., 1965, pp. 255-279, 286-289.

SPIES: Earth/Weather. Silver Burdett.

Weiss, Malcolm E. *Lands Adrift*.

Wilson, J. Tuzo. "Continental Drift," *Scientific American*, April 1963.

Films -- Grandview Heights Public Library

Earthquakes and Volcanoes, 14 min.

Eruption of Kilauea, 27 min.

Eternal Change: Story of a Mountain, 14 min.

The Geological Work of Ice, 11 min.

Mountains, Plains, and Plateaus, 18 min.

The Rise and Fall of the Great Lakes, 17 min.

Filmstrips

Various filmstrips relating to geology are available from school libraries, science rooms, and the IRC.

Transparencies

Earth Science, Geology, and Rocks and Minerals. Milliken transparency books, available from science room in each elementary building.

Kits and Materials

Washington School Collection -- a large box of rock specimens
Nystrom study prints of geology and earth's features

Exemplary Activity
Grade 6
Unit: Geology

OBJECTIVE: To understand how the earth's continents have moved and to trace the facts and logic that led scientists to discover that movement

MATERIALS AND EQUIPMENT: Nystrom globe, National Geographic ocean maps (if possible), maps or drawings showing Pangea breakup

PROCEDURE:

The major facts and terms to be studied are: ridge, sonar, and Pangea.

I. A New Look at Spaceship Earth

   A. The earth as a puzzle
      1. Continents as pieces of the puzzle
      2. Ancient mountains and fossils as clues to the puzzle
      3. Mid-ocean ridges as guides for solving the puzzle (sonar is used to map the sea floor)
      4. Records in the rocks as keys to solving the puzzle

         a. "Compass Rocks": when molten rock cools, its mineral grains become permanently magnetized in the direction of the poles.

            Analogy: a compass needle rusted in place

            Old rocks are found magnetized in directions other than the poles. This proves their continents have moved.

         b. "Calendar Rocks": scientists have learned to tell when a rock was formed. Rock near ocean ridges is very young and becomes older away from the ridge. Continents can be "back-tracked" to see how and when they fit together along a ridge.

   B. Solving the earth puzzle
      1. Pangea: the continents formed one super-continent about 200 million years ago.
      2. The breakup of Pangea: we can trace the splitting up of Pangea over those 200 million years and make a guess at the look of the world of the future.

   C. Activities
      1. Show the ocean ridges on a globe.
      2. Make globes showing the breakup of Pangea.
      3. Construct a timeline showing the age of the earth at the different stages of the Pangea breakup.
      4. Write about the animals and plants that lived when the earth looked so different.

OBJECTIVE: To enable the student to examine the basic structures of the earth and their interrelationships

MATERIALS AND EQUIPMENT: Samples of basalt and granite, if possible; Nystrom globe from science room

PROCEDURE:

The major facts and terms to be studied are: sorting, core, mantle, solid flow, plume, crust, basalt, granite, continent, rebound, hot spot, and plate.

II. Inside Spaceship Earth

A. The process of sorting: as the earth was formed, its materials separated by weight into three main layers -- core, mantle, and crust.

Analogy for the sorted earth: an Easter egg

Earthquake waves are used to "map" the inner earth.

B. The results of sorting

1. Core: the heaviest material, mainly iron and nickle, settled to the earth's center where heat caused by the great pressure partly melted it. The core makes the earth a great magnet.
2. Mantle: most of the rest of the material formed a heavy, solid, hot rock shell outside the core.

   The mantle has a weak zone about 60 miles (100 kilometers) below the surface where the solid rock is weak and can bend.
   a. Bent mantle: the mantle is dented under great weights such as continents.
      Analogy: a balloon with a weight on it
   b. Solid flow: solid rock in the weak zone can also flow a few inches a year.
      Example: solid flow in a glacier
   c. Plume: heated rock may flow (solid flow) up from deep within the mantle to its top. This plume pushes aside other rock, which eventually sinks back into the mantle.
3. Crust: a black, lightweight rock called basalt cooled to form a crust over the top of the mantle. Embedded in it are great masses of an even lighter, usually pinkish, rock called granite. Granite is the main rock making up our continents.
   a. Bending crust: the crust and the strong upper part of the mantle together sometimes are bent down into the mantle.
      (1) Bent crust: the crust is bent under great weights such as continents, mountain ranges, and glaciers.
          Examples: Himalaya Mountains, Greenland, Antarctica
      (2) Rebounding crust: when great weight is removed, the crust will rebound.
          Examples: Scandinavia and southeastern Canada recovering from ice age glaciers

b. Broken crust
   (1) Hot spots: upward pressure from a plume can heat the upper mantle and crust, causing a hot spot. It may break through the crust, allowing molten rock to flow out and form a volcano.
   Example: Hawaii
   (2) Plates: the hot spot may cause the crust and upper mantle to break in a long crack.
   Example: the Mid-Atlantic Ridge where Pangea split apart
   This crack may connect with others to form the edges of a plate. A plate is formed of upper mantle and basalt crust. It may carry a granite continent embedded in it. There are about 10 major plates on the earth and many small ones.
   Analogy: a cracked Easter egg
   Example: the Antarctic plate, carrying the smaller granite continent of Antarctica.

C. Activities:
1. Draw a labeled cross-section of the earth, showing these structures and processes.
2. Pretend you have a futuristic earth-borer and can travel deep into the earth. Write a description of what you find.
3. Read about Hawaii and find out how its islands were formed.
4. Find on a Nystrom globe or draw in chalk on a globe the boundaries of the earth's main plates.

OBJECTIVE: To introduce the concept of plate tectonics and to understand how this process is changing the face of the earth

MATERIALS AND EQUIPMENT: Nystrom globes, National Geographic ocean maps

PROCEDURE:

The major facts and terms to be studied are: plate tectonics, sink, trench, continental drift, and fault.

III. On Spaceship Earth

A. Plate tectonics as a continuing process: the plates on the earth's surface are moved about by interaction between crust and mantle. In the process, many of the large-scale features of the earth's surface were and are being formed.

1. Splitting crust: plates cracked in two are moved apart by pressure of the light, hot rock of plumes and hot spots as new rock flows up to fill in the crack. Mantle rock pushed aside by the plume may carry the plate with it.
   Example: Iceland as part of the Mid-Atlantic Ridge

2. Sinking crust: the side of a plate away from its cracking ridge sinks down into the weak zone of the mantle. It may help to drag the plates apart. Sinks form the lowest places on the earth's surface; these are called ocean trenches. Often they are bordered by volcanic islands.
   Examples: Japan Trench, the Pacific Ocean "ring of fire"

3. Splitting continent: hot spots under a continent can split it apart as they did Pangea, forming volcanoes, low areas, and long narrow seas.
   Example: the Great Rift Valley of Africa and the Red Sea

4. Carried continent: if a continent is embedded in a plate, it is carried wherever the plate moves. This is continental drift.
   Example: Australia since the Pangean breakup

5. Continent at a sink: a plate can sink back into a mantle. Its light granite passenger continent does not. When a continent is carried against a sink, it crumples back onto itself, forming mountains and causing earthquakes and volcanoes.
   Example: Andes Mountains at the Peru Trench

6. Continents in collision: if two continents are carried into one another, they weld into a new continent, creating a great mountain range where they join.
   Example: Asia and India along the Himalayas

7. Passing continents: as two plates are pushed past each other, earthquakes occur along their sides. Sometimes these side edges of plates are in continents and great damage can result from their movement along this fault zone.
   Example: North American and Californian plates along the San Andreas Fault

B. Plate tectonics as a key to other sciences
   1. Geography and geology: spaceship earth is built of many interdependent structures.
   2. Earthquakes and volcanic eruptions: prediction and even control of these may be possible.

3. Mineral resources: deposits of oil and minerals like iron, manganese, copper, and gold are affected by activity at plate boundaries. This new view of geology will open new sources for these materials.
4. Energy sources: understanding the earth's inner workings may allow us to tap hot spots as energy sources.

C. Activities:
1. Draw and label diagrams of earth features caused by moving plates.
2. Make models of these features.
3. Read newspaper stories about earthquakes or volcanoes, or read about older ones in an atlas. Find their location on a globe. Decide if they are caused by plate movement and what kind of movement it might be.

Evaluation Sample
Grade 6
Unit: Geology

Although a teacher-made test follows, it is frequently not necessary, and other methods of evaluation can be used. Oral or written reports by individuals or groups on the various aspects of the unit is one approach. Another is the notebooks or daily records that have been kept by the students and the evaluation thereof. Group projects in paper-mache' or salt dough of various constructive or destructive forces is a third, while a display of rocks and rock formations with accompanying oral explanations for parents or other classes is a fourth.

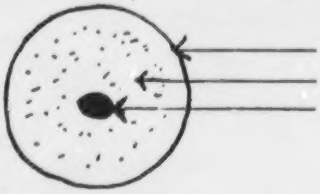
Test

Word List

1. kettle
2. sill
3. marble
4. mantle
5. meandering
6. fault
7. tsunami
8. V-shaped
9. Pangea
10. Matterhorn
11. caldera
12. core
13. a a
14. moraine
15. reverse
16. neck
17. continental drift
18. cirque
19. basalt
20. U-shaped
21. dike
22. trench
23. granite
24. Horst
25. pumice
26. normal
27. pahoehoe
28. sedimentary
29. strike slip
30. Graben
31. sandstone
32. obsidian
33. crust
34. mountains

Fill in the blank with the number of the proper word from the word list above.

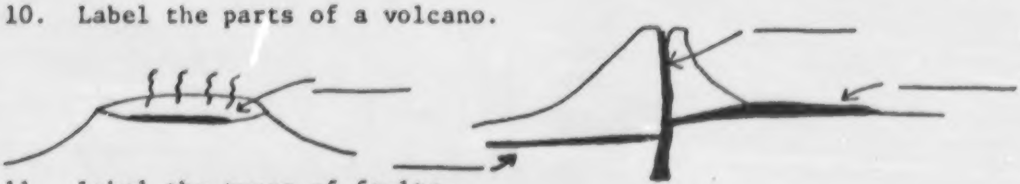
1. Label the three parts of the earth's interior.



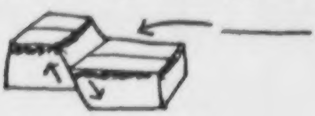
2. The main rock of the crust is __________.
3. The rock that "floats" in the crust to make our continents is _________.
4. When a continent is on a plate and is carried with the plate, this is called ________.
5. The "super continent" of 200 million years ago is called ________.
6. When a plate sinks in a weak part of the mantle, it forms a ________.
7. When plates with continents collide, they form __________.
8. When plates pass each other, they can form __________ zones.
9. Four characteristic rock products that are formed from volcanic activity are _________, __________, _________, and _________.

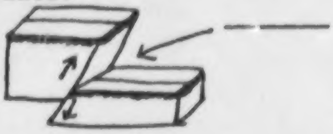
Evaluation Sample (Cont.)
Grade 6
Unit: Geology

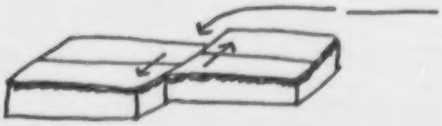
10. Label the parts of a volcano.



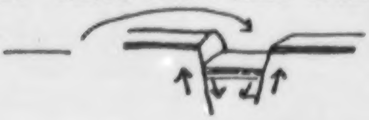
11. Label the types of faults.

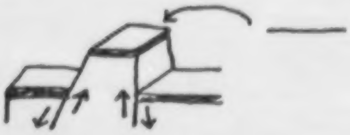






12. Label these land formations.





13. A large wave caused by faulting on the ocean floor is a ________.
14. The type of rock generally found in an area that had once been a shallow sea is called _______.
15. The type of rock you would generally find in areas that had once been beaches, river deltas, etc. is ________.
16. The shape of a valley formed by a fast-moving stream would be a ______ valley.
17. The shape of a valley made by a moving mountain glacier would be a _____ valley.
18. A slow-moving stream in a wide valley frequently becomes a ______ stream.
19. Four land features associated with glacial activity are ________, ______, ______, and ______.
20. A metamorphic rock produced when limestone is subjected to great heat and pressure is called ______.

____

21. Define igneous rock and give an example.

22. Define sedimentary rock and give an example.

23. Define metamorphic rock and give an example.

Unit Outline
Grade 6
Unit: Chemistry and Kitchen
Physics

Description of Unit: The unit will define and explain such basic building blocks as matter, atoms, molecules, elements, compounds, and mixtures. The student should also become familiar with the atomic element chart and some of the chemical symbols and formulas. The ESS unit Kitchen Physics will allow the student to investigate the properties of some common liquids -- water, soapy water, oil, alcohol, and syrup. In laboratory experiments the student will consider such attributes of liquids as how they are absorbed, drop, stream, and interact with various surfaces.

I. Properties of Liquids

A. Drops and heaping
  1. Size and shape of drops on different surfaces
  2. Density of various liquids
    a. Water
    b. Cooking oil
    c. Soapy water
    d. Alcohol
  3. Differences in beading
B. Bottles and streams
  1. Beading of water columns
  2. Surface tension
C. Skinlike effect
  1. Soap vs. water
  2. Alcohol vs. water
  3. Boundary surface as opposed to buoyancy
D. Balancing
  1. Construction of balance beams
  2. Variables in balancing objects
  3. Meaning and use of fulcrum
E. Grabbiness
  1. Measuring surface tension
  2. Construction of tensiometer
  3. Discussion of cohesion
F. Blotters and towels
  1. Absorption
  2. Evaporation
  3. Water rising in tubes
    a. Time required
    b. Differences in thickness of tube
  4. Water rising in blotters
  5. Discussion of meniscus

II. Skills and Concepts

A. Observation
B. Classification
C. Measurement
D. Data collection and organization
E. Prediction
F. Inferences
G. Making and testing hypotheses

Suggested Activities
Grade 6
Unit: Chemistry and Kitchen
Physics

OBJECTIVE: To examine and discuss the properties of a drop of water, soapy water, cooking oil, and alcohol; to compare their properties

TITLE: "Getting to Know a Drop"

SOURCE: Kitchen Physics, ESS teacher's guide

OBJECTIVE: To examine the effect of boundary surfaces of liquids (skinlike effect) on various objects

TITLE: "Tug-of-War"

SOURCE: Kitchen Physics, ESS teacher's guide

OBJECTIVE: To examine the density and weight of various liquids; to observe the "grabbiness" of liquids

TITLE: "How Does This Grab You?"

SOURCE: Kitchen Physics, ESS teacher's guide

OBJECTIVE: To observe the absorption and evaporation of liquids and to determine variables affecting the speed and ease of absorption and evaporation

TITLE: "Blotters and Towels"

SOURCE: Kitchen Physics, ESS teacher's guide

Resources
Grade 6
Unit: Chemistry and Kitchen Physics

Text Materials

Concepts and Challenges in Physical Science, Chemistry, Book 1. Cebco Publishing Company.

Exploring Science, Red Book. Laidlaw Brothers, 1979.

Fun With Chemistry. Random House, 1972.

Gateways to Science. McGraw-Hill, 1979.

Kitchen Physics. ESS Teacher's Guide.

Science for Tomorrow's World, Grade 6. Macmillan, 1966, pp. 44, 53, 98, 358, 384.

SPIES: Matter, Matter Everywhere. Silver Burdett, 1976.

Films

Kitchen Physics. Available through ESS:
EDC Film Library
39 Chapel Street
Newton, Massachusetts 02160

Filmstrips

Beading of a Water Column -- ESS

Water Pressure at Work -- school library

Water Rising in Blotter Strips Enclosed and Exposed -- ESS

Water Rising in Blotter Strips of Graded Width -- ESS

Kits and Materials

ESS materials kit for Kitchen Physics
A large book of ditto masters to accompany Kitchen Physics
A variety of chemicals are available from the science room in each building.

Exemplary Activity
Grade 6
Unit: Chemistry and Kitchen
Physics

OBJECTIVE: To explore the nature and properties of liquids

MATERIALS AND EQUIPMENT: Two plastic 30 ml medicine cups, two medicine droppers, container for water, large bucket, clear water, soapy water, waxed paper, paper towels, aluminum foil, plastic wrap, hot water and soap for cleaning up, other liquids: milk, cooking oil, alcohol, vinegar, salt water, colored water

PROCEDURE: (Drops and Heaping, from ESS teacher's guide)

Distribute plastic cups, medicine droppers, and pieces of waxed paper to children. Place all materials on newspaper-covered desks. Give each student some water.

Instruct students to put several drops of water on the waxed paper and to observe the drops closely. Have them share their observations. (Drops are round; when two drops are placed close together, they quickly join into one drop; the print of the newspaper looks bigger through a drop of water; you can lead the drops around on the waxed paper.)

Ask children to put as much water into the cup as they can. This is called "heaping." Discuss their results. Have students try the same experiment with soapy water and compare their findings.

Have students examine drops of other liquids. Do different surfaces affect the size and shape of the drops? Why do some liquids take longer to drop?

Ask students to try to float a drop of cooking oil on the water. Have them reverse the experiment and discuss their hypotheses.

When discussing the students' results, use the terms "density" (heaviness), "viscosity" (thickness), and "surface tension" (grabbiness).

Answer these questions:

1. Are drops of different liquids the same size? What determines if they are different?
2. Is there a relationship between drop size and heaping in cups for each liquid?
3. Do different liquids make similar drop prints?
4. Does the distance through which a liquid falls make a difference in the size of the print?
5. How is the heaping of soapy water affected if you increase the amount of soap?
6. If an oil drop, a water drop, and a soapy water drop are rolled down a piece of glass, which will win the race?

Evaluation Sample
Grade 6
Unit: Chemistry and Kitchen Physics

Since the students will reach various conclusions and some will experience results that others do not share, a teacher-made test is not recommended. Instead, it would be advisable to have the students keep a notebook of their experiences, including the experiments, hypotheses, inferences, and conclusions. This notebook should include graphs for measurement comparison and diagrams of the experiments, as well as pictures.

The students should keep a vocabulary list of words involved in this unit and they could be tested on these words at the end of the allotted time. The list could include the following words:

density
viscosity
surface tension
hypothesis
inference
grabbiness
adhesion
absorption
evaporation

matter
atom
molecule
element
compound
mixture
symbol
formula
atomic energy

The completion of this unit does not demand that all of these scientific terms be known at this time, but some teachers might wish to introduce and emphasize many of these terms at the sixth grade level.

Unit Outline
Grade 6
Unit: Solar Energy and
Conservation

I. What Is the Sun?
   - A. What is the location of the sun in the universe?
   - B. What chemical components are found in the sun?
      - 1. Gases composed of chemical elements
      - 2. Use of a spectroscope
   - C. Theories relating to star creation and evolution

II. What Is the Source of Solar Energy?
   - A. How much solar energy reaches the earth?
   - B. How does solar energy heat the earth?

III. How Is Solar Energy Controlled?
   - A. In what ways can solar energy be collected?
   - B. How is solar energy stored for home use?
   - C. How is solar energy used in solar stills?
   - D. How can solar energy be converted directly into electricity?

Suggested Activities
Grade 6
Unit: Solar Energy and
Conservation

OBJECTIVE: To understand the cause of a solar eclipse

TITLE: "Cause of a Solar Eclipse"

SOURCE: Jacobson, Lauby, Konicek. Investigating in Science. New York: American Book Co., 1965.

OBJECTIVE: To see the differing colors of various elements

TITLE: "The Spectra of Various Elements"

SOURCE: Jacobson, Lauby, Konicek. Investigating in Science. New York: American Book Co., 1965.

OBJECTIVE: To see how light brightness changes as the distance is increased

TITLE: "The Relationship of Light Intensity to Distance"

SOURCE: Jacobson, Lauby, Konicek. Investigating in Science. New York: American Book Co., 1965.

OBJECTIVE: To demonstrate the greenhouse effect of heating and to measure the varying temperatures

TITLE: "The Greenhouse Effect"

SOURCE: Jacobson, Lauby, Konicek. Investigating in Science. New York: American Book Co., 1965.

OBJECTIVE: To see how lightness and darkness affect the absorption of solar energy

TITLE: "The Absorption of Solar Energy -- Lightness and Darkness"

SOURCE: Jacobson, Lauby, Konicek. Investigating in Science. New York: American Book Co., 1965.

OBJECTIVE: To see how the type of material affects the absorption of solar energy

TITLE: "The Absorption of Solar Energy — Materials"

SOURCE: Jacobson, Lauby, Konicek. Investigating in Science. New York: American Book Co., 1965.

OBJECTIVE: To construct a sundial and understand what it demonstrates

TITLE: "Making a Sundial"

SOURCE: Jacobson, Lauby, Konicek. Investigating in Science. New York: American Book Co., 1965.

OBJECTIVE: To understand how a simple solar reflector works

TITLE: "Using a Solar Reflector"

SOURCE: Jacobson, Lauby, Konicek. Investigating in Science. New York: American Book Co., 1965.

OBJECTIVE: To construct and understand the operation of a simple solar still

TITLE: "Making a Solar Still"

SOURCE: Jacobson, Lauby, Konicek. Investigating in Science. New York: American Book Co., 1965.

OBJECTIVE: To demonstrate how impurities can be removed from water

TITLE: "Removing Impurities From Water"

SOURCE: Jacobson, Lauby, Konicek. Investigating in Science. New York: American Book Co.; 1965.

OBJECTIVE: To construct and understand the use of a solar heater

TITLE: "Constructing and Using a Solar Heater"

SOURCE: Jacobson, Lauby, Konicek. Investigating in Science. New York: American Book Co., 1965.

Resources
Grade 6
Unit: Solar Energy and
Conservation

Text Materials

Award Winning Energy Education Activities. Energy Research and Development Administration, 1977.

Energy, A Teacher's Introduction to Energy and Energy Conservation. Columbus, Ohio: Ohio Department of Education, 1975.

Energy Conservation Experiments You Can Do. Detroit, Michigan: Thomas Alva Edison Foundation, 1977.

Exploring Science. Laidlaw Brothers, 1979.

Gateways to Science. McGraw-Hill, 1979.

Houck, Oliver A. The Best Present of All. Washington, D.C.: National Wildlife Federation.

Jacobson, Lauby, Konicek. Investigating in Science 6. New York: American Book Company, 1965.

Langley, R. Teaching Elementary Science. W. Nyack, N.Y.: Parker Publishing Co., Inc., 1968.

Schultz, R.F. Environmental Experiments from Edison. Detroit, Michigan: Thomas Alva Edison Foundation, 1974.

Films -- Grandview Heights Public Library

A Light Beam Named Ray. Handel, 20 minutes

Filmstrips

Energy and the Environment. Macmillan Publishing Co., 1974.

Harnessing the Sun. National Geographic Society, 1977.

This World of Energy. National Geographic Society, 1974.

Transparencies

Branley, Franklin. Solar Energy. New York: Thomas Crowell Co., 1957.

Materials

Radiometer, solar lens, prisms, solar energy kits, and solar energy lesson plans

Exemplary Activity
Grade 6
Unit: Solar Energy and
Conservation

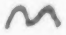
OBJECTIVE: To construct and use a solar heater

MATERIALS AND EQUIPMENT: A shallow paper box, cotton batting, cardboard, black paint, rubber tubing, a pane of window glass, tape, large bottle, two-holed stopper

PROCEDURE:

Cover the bottom of the paper box with cotton batting or some other insulating material. Insulating material is a poor conductor of heat and prevents heat loss.

Cover the insulating material with a piece of cardboard and paint the cardboard a dull black color. Dark colored objects are good absorbers of radiant energy.

Over the cardboard, curl a long length of rubber tubing in the form of . Make two holes in one side of the box. Push the ends of the rubber tubing through the holes. Cover the box with a pane of window glass. Fasten the glass securely by using tape. The glass will allow radiant energy to pass, but it will trap most of the reradiated heat waves (greenhouse effect).

Tilt the paper box so that the pane of glass is at right angles to the rays of the sun and so that one end of the rubber tubing is higher than the other end.

Use a large bottle, such as a milk bottle or a gallon jug, to serve as a hot water tank. Insert a two-holed stopper that holds two pieces of glass tubing, one long and one short, going into the bottle. Fill the large bottle and rubber tubing with water.

Connect the lower end of the rubber tubing to the short piece of glass tubing and the upper end of the rubber tubing to the long piece of glass tubing. Fasten the bottle upside down on a stand so that its lower end is just above the top of the solar heater.

As the water in the tubing in the solar heater becomes warm, it will rise through the tubing into the long piece of glass tubing in the bottle. This heated water will be replaced by colder water that enters the solar heater through the short piece of glass tubing. As water is heated, it expands and becomes less dense. Therefore, the warm water rises to the top as cold water pushes the warm water upward. This is the transfer of heat by convection.

As the water in the heater is heated, it will be constantly replaced by water from the bottle. The water will circulate continuously through the heater and the bottle. After awhile, you should be able to feel the water in the bottle become warmer. You can improve this model solar heater by insulating

PROCEDURE: (Cont.)

the bottle. (Jacobsen, Lauby, Konicek. Investigating in Science 6. New York: American Book Company, 1965, pp. 106-107.)

Doing this lab experience, the class can see the greenhouse effect demonstrated as well as make a model solar heater.

Evaluation Sample
Grade 6
Unit: Solar Energy and
Conservation

Several evaluation methods may be used with the unit on solar energy and conservation.

1. Students are assigned to present research reports on various aspects of solar energy.
2. A "solar energy science fair" where students construct models and posters that demonstrate the concepts of solar energy is held.
3. Students maintain a journal throughout the study of the unit and record pertinent information.
4. A teacher-made test relating to the facts and theories that are presented in the unit can be given.

Unit Outline
Grade 7
Life Science
Unit: Classification

I. Classification Schemes

   A. A large group can be subdivided in a variety of ways.
   B. A large group can be subdivided into general groups that can be further subdivided into more and more specific groups.

II. Classification of Living Things

   A. Naming
      1. Language
      2. Scientific names
   B. Plants (major groups)
   C. Animals (major groups)

Suggested Activities
Grade 7
Life Science
Unit: Classification

OBJECTIVE: To show that the same stack of cards can be grouped in a variety of ways

TITLE: "Forget About the Joker"

SOURCE: Wong and Dolmatz. Biology -- Ideas and Investigations in Science, (IIS). Prentice Hall, Inc., 1971.

OBJECTIVE: To develop a classification system -- large groupings to small

TITLE: "A Jar of Junk"

SOURCE: Unknown

OBJECTIVE: To show that the languages used are Latin and Greek and that an attempt is made to make names as descriptive as possible

TITLE: "Assigning Names"

SOURCE: Abraham, et al. Interaction of Man and the Biosphere. Rand McNally and Company, 1970.

OBJECTIVE: To provide an opportunity for the students to see representative samples of the major divisions of the plant and animal kingdoms

TITLE: "Major Groups in the Plant and Animal Kingdoms"

SOURCE: Teacher developed

OBJECTIVE: To apply a classification system in the identification of trees

TITLE: "Trees"

SOURCE: Teacher modified from Activities for the Land Laboratory, Grades 4-8.

Text Materials

Abraham, Norman, et al. Interaction of Man and the Biosphere. Rand McNally and Company, 1970, pp. 208-225.

Activities for the Land Laboratory, Grades 4-8. Trumbull County Schools, George Morar, Jr., Superintendent. Ohio Department of Education.

Bernstein, Leonard, and Schachter, Martin. Concepts and Challenges in Life Science. Cebco Standard Publishing, 1979.

Brandwein, Paul F. Life -- Its Forms and Changes. Harcourt, Brace, Jovanovich, 1972, pp. 225-229, 246-248, 256, 272-274, 303-305, 309, 338-340, 372-373, 394-395, 419-421.

Richardson, Jenne Taylor. Life Science. Silver Burdett, 1979.

Wong, Harry K., and Dolmatz, Malvin S. Biology -- Ideas and Investigations in Science. Prentice Hall, Inc., 1971, pp. 69-70.

Filmstrips

Classification of the Animals. O.S.U. Library.

Plants -- Division and Structure, Part II. Hastings Library.

Transparencies

The Mammals. Hastings Library.

Our Living World. Hastings Library.

Teacher developed transparencies

Specimens

Plant and animal specimens. Hastings Science Department.

Land Laboratory

Exemplary Activity
Grade 7
Life Science
Unit: Classification

OBJECTIVE: To group objects into sets and subsets on the basis of observed characteristics

MATERIALS AND EQUIPMENT: Assorted objects such as screws, washers, nuts

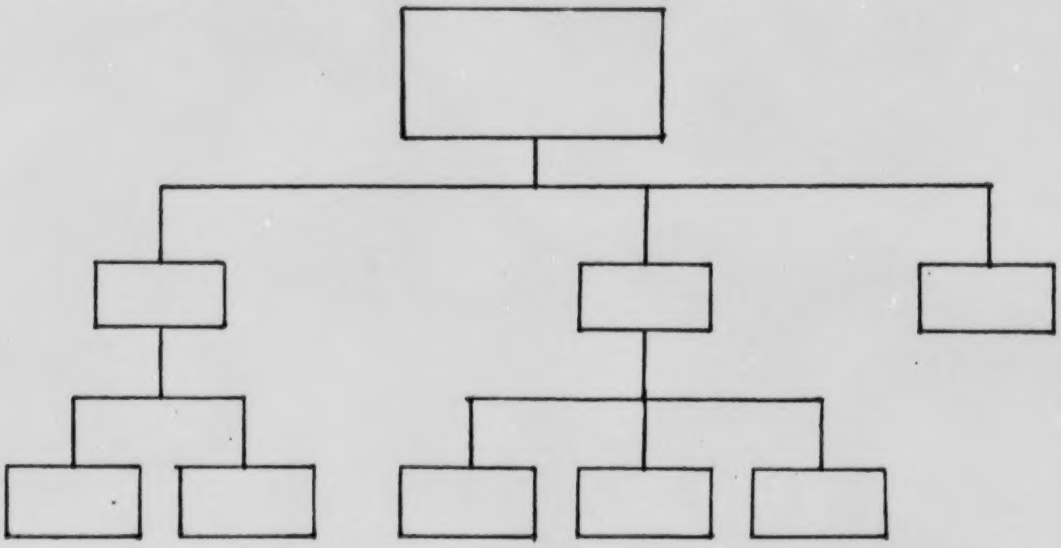
PROCEDURE:

1. Take the jar of objects and dump them all out on the table. Make observations of the kinds, shapes, sizes, and so forth, of the objects.

2. Divide the group of objects into two or three smaller groups. Give a name to each group and write the rules (criteria) for belonging to that group.

3. Continue dividing each group until you have one object in each group. Make sure you name each group of objects and write down the criteria for belonging to that group before you divide it again.

4. When you are finished, draw a diagram like the one below, with the names of your groups in each box. Remember, your diagram may not look like this one, depending on how you divided your groups.



5. Think about what characteristics make up a good classification system, and why classifying is important to scientists.

Evaluation Sample
Grade 7
Life Science
Unit: Classification

Name____________________________

Period _____

True or False -- Use a + for true and 0 for false.

____ "Horse" is a scientific name.

____ If there are 1 1/2 million different kinds of plants and animals, then there are 1 1/2 million species of plants and animals.

____ All worm-like creatures belong to the phylum "Annelida."

____ Vascular plants have tube-like structures that conduct water and food for the plant.

____ The phylum Chordate includes insects.

____ Classification of organisms involves noticing structural similarities, placing the organisms in groups on the basis of those similarities, and assigning names.

____ We can tell how closely related or similar two organisms are by noticing where they are grouped in our classification system.

____ Latin was chosen as the language for our classification system because it is still spoken in most parts of the world.

____ Flowering plants belong to the class Gymnosperms.

The chart below classifies five organisms. Use the chart when answering questions 1 through 5.

fox	cat	horse	dog	crab apple
Animal	Animal	Animal	Animal	Plant
Chordate	Chordate	Chordate	Chordate	Tracheophyta
Mammal	Mammal	Mammal	Mammal	Angiosperms
Carnivora	Carnivora	Perissodactyl	Carnivora	Rosales
Canidae	Felidae	Equidae	Canidae	Rosacae
Volpes	Felis	Equus	Canis	Malus
fulva	domestica	caballus	familiaris	sylvestris

1. ____ There are more structural similarities between a fox and a cat than between a fox and a horse.

2. ____ A crab apple belongs to the family Rosales.

3. ____ The scientific name for a fox is Vulpes fulva.

4. ____ A dog belongs to the order Mammal.

5. ____ From the top to the bottom, which is the correct order for the names of the groups in the chart?

    1. family, kingdom, phylum, order, class, genus, species
    2. kingdom, order, phylum, genus, species, class, family
    3. kingdom, phylum, class, order, family, genus, species
    4. phylum, class, kingdom, order, genus, family, species

____ By looking at the following scientific names,
Felis leo -- lion
Felis tigris -- tiger
Felis domestica -- house cat
you should be able to tell that these animals

1. do not have any structural similarities.
2. have structural similarities, but cannot breed with each other and have normal offspring.
3. have structural similarities and could produce normal offspring, given the chance.
4. all belong to the same species.

(Choose only one answer for each multiple choice question.)

____ Three structural similarities of mammals (and only mammals) are:
1. lungs, jointed legs, diaphragm.
2. claws, hair, backbones.
3. milk glands, hair, diaphragm.
4. bony skeleton, hair, four appendages (arms or legs).

____ All birds
1. are warm blooded and lay eggs.
2. have teeth and feathers.
3. are cold blooded and fly.
4. go to Florida for the holidays.

____ Reptiles can be distinguished from amphibians by
1. claws on their feet (if they have feet).
2. scales instead of skin.
3. lungs throughout their lives.
4. all of the above.

____ Sharks are placed in a different phylum than goldfish because
1. they eat goldfish.
2. goldfish don't have teeth.
3. their size difference is so great.
4. their skeletons are different materials.

Matching I: Select the number of the best answer and place it in the space.

____ The science of classifying
____ The most general group in the classification system
____ The man who started the binomial (scientific) method of classification
____ The two parts of a scientific name of an organism (2 answers)

1. Aristotle
2. genus
3. family
4. kingdom
5. Linnaeus
6. species
7. taxonomy

Matching II: Match the animals on the left to the phylum they belong to on the right. Some phyla may be used more than once.

____ frog
____ grasshopper
____ amoeba
____ rat
____ earthworm
____ tapeworm
____ penguin
____ black widow spider

1. Arthropoda (jointed legs)
2. Protozoa (first animals)
3. Chordata
4. segmented worms (Annelida)
5. flatworms (Platyhelminthes)
6. mollusks
7. roundworms
8. Echinoderms (spiny skinned)

Matching III: Match the descriptions on the left to the plant groups on the right.

____ flowers, covered seeds
____ no roots, stems, or leaves, first successful land plants
____ naked seeds, usually have cones
____ have roots, stems, leaves, reproduce by spores; these kinds were turned into coal

1. fungi
2. algae
3. ferns
4. Gymnosperms
5. Antiosperms
6. mosses

Write your scientific name below, using correct punctuation.

Bonus: Identify the parts of speech that make up your scientific name.

Be sure to include both your given name and your surname on this sheet!

Unit Outline
Grade 7
Life Science
Unit: Structure of Organisms

I. Cells

- A. Cell parts
  - 1. Cell wall and/or membrane
  - 2. Nucleus
  - 3. Cytoplasm
- B. Function of cell parts
- C. Cell specialization -- tissues

II. Protists

- A. Kingdom characteristic
- B. Microscope
  - 1. Compound
  - 2. Stereoscope
- C. Aquarium sampling

III. Plants

- A. Seed plants
  - 1. Parts and functions
  - 2. Cross-section of woody stem
  - 3. Characteristics of tree stem in winter
- B. Remaining plant groups -- comparison of parts to seed plants

IV. Animals

- A. Grasshopper
  - 1. External anatomy and functions
  - 2. Dissection -- internal anatomy and functions
- B. Frog
  - 1. External anatomy and functions
  - 2. Mouth anatomy and functions
  - 3. Dissection -- internal anatomy and functions
- C. Cat
  - 1. Internal anatomy and functions
    - a. Thoracic cavity
    - b. Abdominal cavity
  - 2. Comparative anatomy of grasshopper, frog, cat, and human

Suggested Activities
Grade 7
Life Science
Unit: Structure of Organisms

OBJECTIVE: To discover the importance of the cell as a unit of life and the function of each of its major parts

TITLE: "The Basic Building Blocks of Life"

SOURCE: Teacher developed from class text, Life, Its Forms and Changes

OBJECTIVE: To acquaint students with the use of the microscope to enable students to study cells

TITLE: "It's a Small World"

SOURCE: Modified exercise from Laboratory Manual for the Biological Sciences

OBJECTIVE: To investigate the parts of a flower and discover the relationship of these parts in the process of sexual reproduction

TITLE: "Flowers and the Birds and Bees"

SOURCE: Teacher developed

OBJECTIVE: To discover the relationship between the rings in the cross-section of a tree to growth and climate of past years

TITLE: "A Look at the Past"

SOURCE: Unknown

OBJECTIVE: To arouse student interest in dissection as a tool of investigation in science

TITLE: "Dissection of the Grasshopper"

SOURCE: Sentinel Books

OBJECTIVE: To arouse student interest in human and comparative anatomy as a summary of animal structure

TITLE: "The Cat and Comparative Anatomy"

SOURCE: Teacher developed from How to Dissect, published by Sentinel Books, and Laboratory Anatomy of the Cat, published by W.C. Brown

Resources
Grade 7
Life Science
Unit: Structure of Organisms

Text Materials

Berman, William. How to Dissect. Sentinel Books Publishers, Inc., 1961, pp. 43-52.

Bernstein, Leonard, and Schachter, Martin. Concepts and Challenges in Life Science. Cebco Standard Publishing, 1979.

Booth, Ernest S. Laboratory Anatomy of the Cat. Wm. C. Brown Company Publishers, 1948, pp. 22-25, 27-35.

Brandwein, Paul F. Life, Its Forms and Changes. Harcourt, Brace, Jovanovich, 1972, pp. 70-74, 96-126, 137-141, 291-294, 356-359.

Richardson, Jenne Taylor. Life Science. Silver Burdett, 1979.

Films -- Grandview Heights Public Library

Cells: Structural Unit of Life

Growth of Flowers

Life in a Drop of Water

Filmstrips

Life Sciences: The Plants. Published by Educational Dimensions Group. Hastings Library.

Transparencies

The Microscope. Teacher produced.

Plants. Milliken Publishing. Hastings School, Room 214.

Exemplary Activity
Grade 7
Life Science
Unit: Structure of Organisms

OBJECTIVE: To teach the basic parts of the cell

The cell is the structural and functional unit of life in both plants and animals. In addition to learning the basic parts of the cell, you will discover some ways in which plant and animal cells are different and some ways in which they are alike.

MATERIALS AND EQUIPMENT: See Procedure

Hypothesis: From what I know now about plant and animal cells, I would expect them to be alike in the following ways:____________

____

____

I would expect them to be unlike in the following ways:__________

____

____

PROCEDURE: PART A

1. To obtain animal cells, gently scrape inside of your cheek with blunt end of toothpick. The grayish matter will be dead epithelial cells.

2. Prepare a wet mount slide to observe under the microscope. Spread cells into a drop of water and cover with cover slip.

3. Use low power of microscope first, then high power. Light must be adjusted just right. Move slide to find some unwrinkled cells.

4. Add a drop of methylene blue stain to one edge of cover slip. Apply a small piece of paper towel to opposite edge of cover slip.

5. Move slide around until you find several cells fitting together in a mosaic pattern. Examine under both powers of the microscope.

Observations and Data

1. Make a drawing of epithelial cells and label the parts.

2. What parts of the unstained cells can you identify? ____________________

____

____

3. What part of the cell seems to become stained by the methylene blue?

____

____

____

PROCEDURE: PART B

1. By using probe, remove the thin transparent epidermis from the inside surface of the onion.
2. Prepare a wet mount using a strip of the epidermis. Examine under low power, then high power. Cover the onion with cover slip. Observe to answer observation #1.
3. Stain by using methylene blue and use the same technique as in Part A. Observe to answer observation #2.

Observations and Data

1. What parts of the unstained onion cell can you see? ____________________

____

2. What parts of the onion cell are revealed by staining? ____________________

____

3. Make a drawing of two or three onion cells you observed under the microscope. Label the parts you can identify.

PROCEDURE: PART C

1. Obtain a small leaf from the growing tip of the water plant Elodea.

2. Mount leaf in a drop of water and cover with a cover slip. Examine under low then high power. Record observations in observation #1.

3. Watch what happens to the Elodea cells when a 20% sugar solution is added to the edge of the cover slip. Observe this under high power looking at just one cell.

Observations and Data

1. What structures, not observed in the onion, do you find in the Elodea?

____

____

2. Do you notice any movement within the Elodea cells? ______________

____

3. What happened to the Elodea cell contents upon the addition of the 20% sugar solution? ______________________________

____

Evaluation Sample
Grade 7
Life Science
Unit: Structure of Organisms

CELL QUIZ* Name________________________

Place an X in the box if the following organisms below have the characteristic listed in the columns at the right.	Cell cytoplasm	Cell wall	Cell nucleus	Chloroplast	Cell membrane	Protoplasm
Onion cells						
Epithelial cells						
Elodea cells						
Human nerve cell						
Green blades of grass cells						

1. ________________ 2. ________________ 3. ________________

BONUS: SCIENCE

*Teacher developed

400

Anatomy Quiz*

T F 1. The frog differs from man in that the body cavity is not separated by a diaphragm.

______ 2. The most important muscles in the frog used for breathing are located where?

______ 3. The largest organ in the cat's body is the _______?

______ 4. As you cut through the cat into the body cavity, you go through the following tissues in what order:

A. skin, peritoneum, muscle wall
B. skin, muscle wall, peritoneum
C. peritoneum, skin, muscle wall

5. What are the mesentaries in the frog and cat? ____________________

Matching -- match the letters on the right with the terms on the left.

6.	muscle	a.	breath by diffusion
7.	urinary bladder	b.	dorsal backbone
8.	skin	c.	contract
9.	spleen	d.	opening to lungs
10.	glattis	e.	mole only -- to attract
11.	vertebrate	f.	food catching device
12.	liver	g.	produces bile to digest food
13.	vocal sac	h.	anterior
14.	ventral	i.	stores waste
15.	tongue	j.	belly or underneath
		k.	part of circulatory system

Put a check in the box if the animal has that characteristic.

	labeled wings	4-chambered heart	pronotum
human			
cat			
frog			
grasshopper			

*Teacher developed

Unit Outline
Grade 7
Life Science
Unit: Activities of
Organisms

I. Photosynthesis

  A. Cell's energy process
  B. Dark reaction
  C. Light reaction
  D. Single-celled plants

II. Response

  A. Stimulus-response
  B. Nerve cell
  C. Pathway of nerve impulses

III. Respiration

  A. Anaerobic
  B. Aerobic
  C. Cellular

IV. Digestion

  A. Chemical
  B. Mechanical

V. Reproduction

  A. Sexual
  B. Asexual

VI. Transportation

  A. Circulatory system
  B. Root system

OBJECTIVE: To differentiate the structure of food molecules before and after partial digestion by chemical action

TITLE: "Starch and Sugar Test"

SOURCE: Abraham. Interaction of Man and the Biosphere.

OBJECTIVE: To prove light is necessary for growth of green plants

TITLE: "Light Is Necessary for Green Plants"

SOURCE: Abraham. Interaction of Man and the Biosphere.

OBJECTIVE: To determine that light is needed to make starch

TITLE: "Is Light Needed to Make Food?"

SOURCE: Richardson. Life Science. P. 374.

OBJECTIVE: To observe the process of asexual reproduction

TITLE: "One Potato, Two Potato"

SOURCE: Abraham. Interaction of Man and the Biosphere.

OBJECTIVE: To observe the relationship of structure and function of water absorption in a young root

TITLE: "Observing a Young Root"

SOURCE: Abraham. Interaction of Man and the Biosphere.

OBJECTIVE: To demonstrate that the process of respiration releases carbon dioxide and energy

TITLE: "Respiration and Heat"

SOURCE: Richardson. Life Science. P. 378.

Text Materials

Abraham, Norman, et al. Interaction of Man and the Biosphere. Rand McNally and Company, 1970.

Bernstein, Leonard, and Schachter, Martin. Concepts and Challenges in Life Science. Cebco Standard Publishing, 1979.

Brandwein, Paul. Life -- Its Forms and Changes. Harcourt Brace Jovanovich, Inc., 1972.

Richardson, Jenne Taylor. Life Science. Silver Burdett Co., 1979.

Films -- Grandview Heights Public Library

How Green Plants Make and Use Food

Life in a Drop of Water

Reproduction in Plants

Why Plants Grow Where They Grow

Filmstrips

Leaves of Plants, Hastings Learning Center

Life Cycle of a Plant, Hastings Learning Center

Mitosis -- Animal and Plant, Jones Learning Center

Photosynthesis: Factors Affecting Oxygen Production, Jones and Hastings Learning Centers

Roots of Plants, Hastings Learning Center

Stems of Plants, Hastings Learning Center

Film Loops

Mitosis -- Animal and Plant, Hastings Learning Center

Exemplary Activity
Grade 7
Life Science
Unit: Activities of
Organisms

OBJECTIVE: To investigate human sensitivity to touch and to enumerate some limiting factors in sensing our environment

MATERIALS AND EQUIPMENT: See Procedure

Introduction

All that we know, we learn through our sense organs. They are our ultimate instruments for exploring the environment. It is of the highest importance that we understand what kind of instruments they are, what they can do, and where they fail.

Touch

The skin contains a wide variety of end-organs, specific for pain, heat, cold, pressure, and touch. Touch receptors are of two kinds: bulbous arrangements of cells enclosing the naked terminal twigs of a sensory nerve fiber (Pacinian and Meissner corpuscles), or the widely branching terminal arborization of such a nerve fiber around the basal bulb or "root" of a hair ("hair crown"). With very small stimuli one can map out the locations of the sharply localized points at which stimulation conveys any one of the skin sensations.

We shall map out the touch spots in various areas of skin in this way, using a bristle as stimulus. This will demonstrate a general condition of all receptor systems -- that the receptors form a discontinuous mosaic of isolated sensitive points, relatively coarse in the case of touch, and varying greatly from one area of skin to another. Our sense of spatial continuity -- of the smoothness of a surface -- as well as of pattern is conveyed by such discontinuous mosaics of receptors.

The capacity of a sensory surface for evaluating pattern is measured by determining the "two-point threshold," which is the smallest separation at which two point stimuli are perceived as two. This measures the density of receptors, since for two stimuli to be appreciated as two, they must excite two touch spots having at least one unexcited touch spot between them.

PROCEDURE:

Perform the following experiments in pairs, one student, with eyes closed during each test, serving as subject, the other as experimenter and recorder.

Distribution of Touch Spots

With a pen outline a hairless or shaved area about 3 cm. square on the inner forearm. Explore this area by touching it lightly with the tip of a bristle, noting the points from which a distinct sensation of touch is felt. Mark each of them with a spot of ink. Draw a diagram of the area, showing the locations of the touch spots. Estimate the number per square centimeter.

Two-Point Thresholds

To test for these, the experimenter touches various points in a region of skin very lightly with one or both of the blunted points of a pair of dividers, in haphazard order. At each touch the subject reports the sensation as either "one" or "two."

At the start of each test, adjust the separation of the dividers so that all double stimuli are reported as "two" and all single stimuli as "one." Then gradually lessen the separation until only about eight in ten reports are correct. The separation of the points in centimeters is then the approximate minimum perceptible separation, or two-point threshold. In some areas of skin this is much the same in all orientations of the dividers; in others it differs greatly.

Determine and record in a table the two-point thresholds for the upper arm (longitudinal), upper arm (transverse), back of hand, palm of hand, fingertip and lips. Calculate the number of receptors per square centimeter in each area tested, and enter this in the table. In those areas in which the two-point threshold is about the same in all orientations of the dividers, use the formula: $N/cm^2 = 4/L^2$, in which N is the number of touch spots and L is the two-point threshold in centimeters.

Source: Materials presented in Education 605, The Ohio State University, Fall 1970.

Evaluation Sample
Grade 7
Life Science
Unit: Activities of
Organisms

Reference:

Richardson, Jenne Taylor. Life Science, Teacher's Edition. Silver Burdett, 1979, Chapter Tests 4, 6, 7, 8, 15, 19.

Unit Outline
Grade 7
Life Science
Unit: Ecology

I. Biotic and Abiotic Factors

   A. Physical and atmospheric conditions of environments
   B. Analysis of the natural distribution of selected organisms
   C. Carrying capacity of habitats
   D. Biotic divisions of the earth

II. Interdependence of Populations

   A. Classification of organisms by niche
   B. Food chains and food webs
   C. Formation of climax communities
   D. Patterns of activity within biotic communities

III. Cyclic Patterns and Biotic Systems

   A. Energy flow in different systems
   B. Pollutant pathways in the biosphere
   C. Water, carbon dioxide, oxygen, and mineral cycles
   D. Food patterns of selected species in their habitats

IV. The Role of Ecologists

   A. Job responsibilities of ecologists
   B. Corrective measures for environmental problems
   C. Effects of specific pollutants on organisms
   D. Factors related to survival levels of selected life species

OBJECTIVE: To make predictions concerning human population increases using graphical analysis of data

TITLE: "Warning -- S-Curve Ahead"

SOURCE: "Crusty Problems -- Why You're You," Environmental Science, ISCS, Chapter 8.

OBJECTIVE: To investigate the effects of temperature on the respiration of fish and determine the survival levels of fish at different environmental temperatures

TITLE: "Getting All Steamed Up"

SOURCE: "Environmental Crises," Probing the Natural World, Experimental Edition, Florida State University, 1970, E 5.1, pp. 1-4.

OBJECTIVE: To interpret data and complete a map of the natural distribution of plants on the North American continent

TITLE: "Biomes"

SOURCE: Teacher developed exercise using IMB pp. 182-85
Climate and the World of Man and the Biosphere, film

OBJECTIVE: To enumerate the factors that determine the natural distribution of animals on the earth

TITLE: "Realms"

SOURCE: Teacher developed from Life, Its Forms and Changes, pp. 517-518.

OBJECTIVE: To investigate the effects of different levels of pollutants on the germination of seeds

TITLE: "Pollution and Germination"

SOURCE: "Environmental Crisis," Probing the Natural World, Experimental Edition, Florida State University, 1970, pp. 4-13.

OBJECTIVE: To investigate the way biochemical oxygen demand of microorganisms is affected by pollution

TITLE: "Water, Water Everywhere...But..."

SOURCE: "Environmental Crises," Probing the Natural World, Experimental Edition, Florida State University, 1970, pp. 2-13.

OBJECTIVE: To interpret data and generate a food web

TITLE: "Tidal Pool Food Web"

SOURCE: Life, Its Forms and Changes, pp. 26-31.

OBJECTIVE: To identify the causes, stages, and climax types of a particular habitat

TITLE: "Ecological Succession"

SOURCE: Interaction of Man and the Biosphere, pp. 200-201.
Ecological Succession, slide set

OBJECTIVE: To enumerate the important characteristics used to identify a bird and to explain the ecological niche occupied by different bird species

TITLE: "A Field Study of Birds -- Bird Hunt"

SOURCE: Teacher modified from Activities for the Land Laboratory, Grades 4-8.

Resources
Grade 7
Life Science
Unit: Ecology

Text Materials

Abraham, Norman, et al. Interaction of Man and the Biosphere. Rand McNally and Co., 1970, pp. 158-160, 162-165, 182-188, 200-201.

Activities for the Land Laboratory, Grades 4-8. Trumbull County Schools, George Morar, Jr., Superintendent. Ohio Department of Education.

Bernstein, Leonard, and Schachter, Martin. Concepts and Challenges in Life Science. Cebco Standard Publishing, 1979.

Blaustein, Elliott H., and Blaustein, Rose. Investigating Ecology. Arco Publishing Company, 1978.

Brandwein, Paul F. Life, Its Forms and Changes. Harcourt, Brace, Jovanovich, 1972, pp. 26-31, 55-83, 517-518.

Richardson, Jenne Taylor. Life Science. Silver Burdett, 1979.

Films -- Grandview Heights Public Library

Climate and the World of Man and the Biosphere

Filmstrips

Preserve and Protect, Jones Library

Transparencies

Biomes, Hastings Library

Slides

Ecological Succession, Hastings Library

Supplemental Materials

Environmental Science, ISCS

Land Laboratory

Exemplary Activity
Grade 7
Life Science
Unit: Ecology

OBJECTIVE: To realize that all the living things of the biosphere are joined together in a web of life; to determine that plants are producers, animals are consumers; to learn that no one species completely dominates another in a stable community; instead, there is a balance in nature

MATERIALS AND EQUIPMENT: See Procedure

PROCEDURE:

The members of a community are linked by their eating habits. The chain begins, of course, with green plants. A green plant uses the energy from the sun to make food. A herbivore then comes along and eats the plant. Energy is transferred from the sunlight to the plant and then to the herbivore.

Fortunately for the community, the chain reaches further than to the herbivore, a primary consumer. A secondary consumer captures the herbivore and eats it. Again there is no breaking of the chain. A third-order carnivore feeds upon the secondary consumer. Thus, we have the transfer of food and energy from the producer to higher consumers. This sequence is known to the ecologist as a food chain.

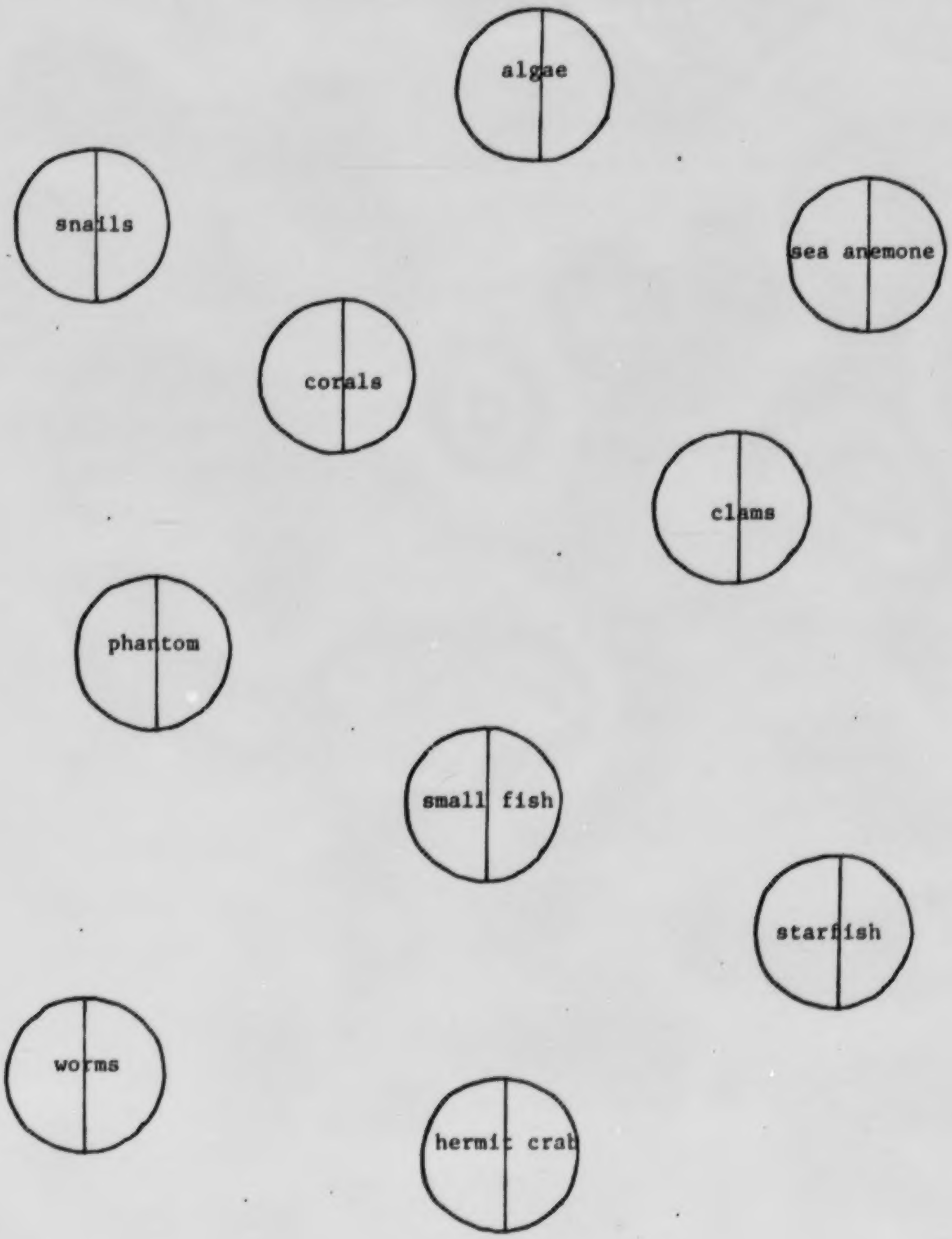
All the interactions involving the feeding of a community simply cannot be shown by a row of chains lying side by side. In reality, the chains are interlocked with one another. Instead of separate food chains, we have what the ecologist refers to as a food web.

Follow the steps below to complete the activity:

1. Read in your text pages 26-31.
2. Observe the preserved specimens on the counter.
3. Write each organism down and describe its eating habits.
4. Determine what position each has in the food web.
5. Complete the food web.
6. Complete the questions of interpretation.

Exemplary Activity (Cont.)
Grade 7
Life Science
Unit: Ecology

Name ______________________ Section ______ Group ______


algae
snails
sea anemone
corals
clams
phantom
small fish
starfish
worms
hermit crab

MARINE FOOD WEB

Questions of Interpretation

1. Identify four or more of the animals you can see in the marine community.

2. What is the difference between photoplankton and zooplankton?

3. What animals are probably in the tidal pool but not included in drawing?

4. How do the animals that are attached to the bottom of the tidal pool obtain their food?

5. What things might affect the amount of light that penetrates the water?

6. What mutual relationship exists between a hermit crab and a sea anemone?

7. Why is microscopic marine algae called the "grass" of the sea?

8. What are shellfish?

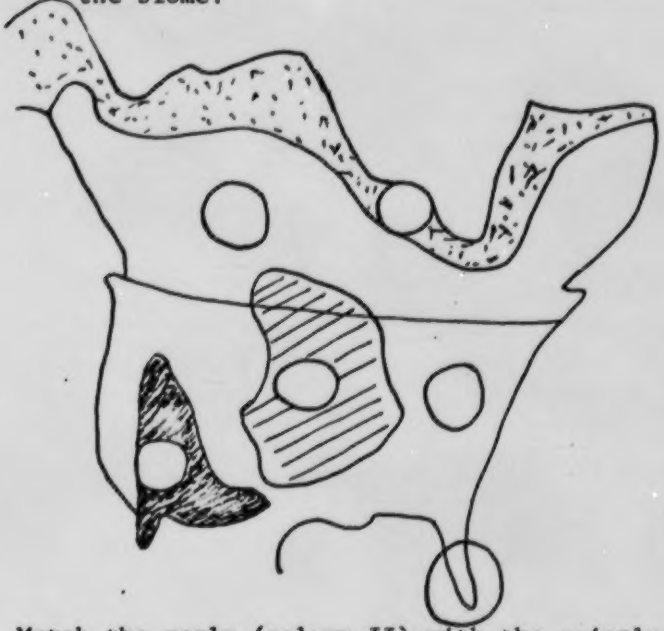
9. What does picture #2 on page 30 show?

10. What environmental conditions exert an influence on aquatic communities?

Evaluation Sample
Grade 7
Life Science
Unit: Ecology

TEST -- Ecology　　　　　　　　Name ______________________________

1. In the map below, fill in the circle with the correct letter that matches the biome.



A. Tropical rain forest

B. Grassland

C. Deciduous forest

D. Tundra

E. Coniferous forest

F. Desert

Match the realm (column II) with the animals found in that area (column I).

2. ____ peacock

3. ____ giant anteater

4. ____ zebra

5. ____ rattlesnake

6. ____ hedgehog

7. ____ koala bear

8. ____ Marco Polo sheep

9. ____ hummingbird

10. ____ Bengal tiger

11. ____ American bison

12. ____ kangaroo

A. Nearctic

B. Palearctic

C. Neotropical

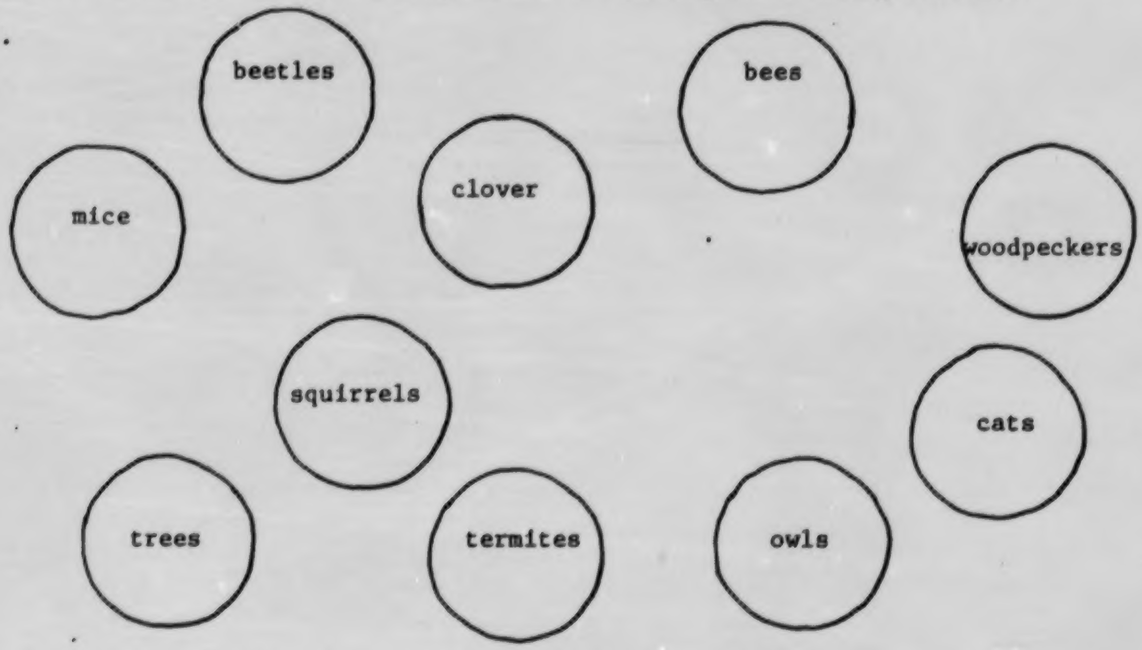
D. Ethiopian

E. Oriental

F. Australian

Complete the following by drawing arrows to the organisms being consumed.

13.


beetles
bees
clover
mice
woodpeckers
squirrels
cats
trees
termites
owls

The following is a list of biotic and abiotic factors found in a small ecosystem. If the factor is biotic, mark with a capital B. If the factor is abiotic, mark with a capital A.

14. ____ 75°F
15. ____ cattle
16. ____ wheat
17. ____ soil
18. ____ cows
19. ____ grass
20. ____ humidity
21. ____ sunlight
22. ____ barns
23. ____ soybeans
24. ____ tractor
25. ____ air
26. ____ moss
27. ____ stones
28. ____ water

Define the words below:

29. producers -

30. ecology -

31. biome -

32. decomposer -

33. ____ The land biomes of the world have been named according to the (a) dominant animal (b) climate (c) temperature (d) dominant vegetation.

34. ____ At the beginning of any food web is a (an) (a) producer (b) primary consumer (c) secondary consumer (d) decomposer.

35. ____ Desert animals obtain water from (a) seeds (b) water holes (c) plant stems (d) all of the above.

36. ____ A balanced community is likely to contain (a) producers (b) decomposers (c) consumers (d) all of the above.

37. ____ The best example of a scavenger is (a) man (b) coyote (c) vulture (d) algae.

38. ____ A producer in a pond community would be (a) trout (b) snails (c) pond weeds (d) frogs.

39. ____ The annual rainfall in the desert is usually (a) greater than 100 inches (b) greater than 10 inches, but less than 20 inches (c) between 20 and 50 inches (d) less than 10 inches.

40. ____ Deserts are present on the eastern side of mountain ranges because (a) the soil is naturally adapted for deserts (b) there is a heavy rainfall on western sides leaving no water for deserts (c) rain always runs down western sides (d) none of the above.

41. ____ A fish is washed up on a beach. It is no longer in its normal (a) succession (b) habitat (c) species (d) niche.

42. ____ The main kind of plant food eaten in a tidal pool is (a) starfish (b) microorganisms (c) sea anemones (d) sand dollars.

43. ____ The deciduous forest region is characterized by (a) oaks, maples, and ashes (b) winters that do not interrupt the growing season (c) less than 20 inches of rainfall (d) coniferous trees.

44. ____ The world's most abundant vegetative growth occurs in the (a) coniferous forest (b) prairie (c) rain forest (d) tundra.

Fill in the blanks.

45. The producers in the world are ______________________.

46. ______________________ are organisms in the soil that break down dead organic matter into elements or compounds.

Evaluation Sample (Cont.)
Grade 7
Life Science
Unit: Ecology

47. The interrelationships that exist in the sequence of events whereby plants are consumed by animals and these in turn are also consumed is called ________________ ____________________.

48. Realms are classified by the factors of ____________________ and ______________________.

Match the following.

49.	____ adapt	A.	place where an organism lives
50.	____ habitat	B.	plant eater
51.	____ environment	C.	surroundings
52.	____ biome	D.	herbivorous animal
53.	____ omnivores	E.	large plant and animal community
54.	____ man	F.	trees that lose their leaves
55.	____ deciduous	G.	adjust to new conditions
56.	____ sheep	H.	meat eater
57.	____ carnivore	I.	omnivorous animal
58.	____ herbivore	J.	animals that eat anything

True-false statements (use an X for true and an O for false).

59. ____ Scavengers and decomposers eat any dead thing.

60. ____ The treeless arctic region is called the coniferous forest.

61. ____ Animals that feed on insects are called primary consumers.

62. ____ A niche is what a particular organism does in a community.

63. ____ To be classified as an ecosystem, there must be biotic and abiotic factors.

Teacher developed

Reference:

Activities for the Land Laboratory, Grades 4-8. "Attitude Test," a measure of interest and attitudes of students toward environmental matters. Trumbull County Schools, Goerge Morar, Jr., Superintendent. Ohio Department of Education.

Unit Outline
Grade 7
Life Science
Unit: Heredity and Evolution

I. Characteristics of Organisms

   A. Dominant and recessive traits
   B. Hybrids and blending
   C. Gregor Mendel and his laws
      1. Trait pairs
      2. Dominance
      3. Independent assortment
   D. Gene theory
      1. Chromosomes
      2. Reduction division
      3. Punnett square
      4. Sex determination
      5. Sex-linked traits
      6. Multiple-gene inheritance
   E. The nucleus and DNA
      1. Mutations
      2. Laws of chance

II. Heredity and the Environment

   A. Populations of organisms
   B. Environmental pressure and natural selection
   C. Life in the past
   D. Mutations and the Theory of Evolution
   E. Practical applications
      1. Plant breeding
      2. Animal breeding

Suggested Activities
Grade 7
Life Science
Unit: Heredity and Evolution

OBJECTIVE: To acquaint students with Mendel's Laws and the Punnett square and to provide motivation by using a human characteristic

TITLE: "Blood Typing"

SOURCE: A Sourcebook for the Biological Sciences. Morholt, et al., 1966, p. 253.

OBJECTIVE: To become aware of human characteristics that can be interpreted using Mendel's Laws

TITLE: "Human Characteristics"

SOURCE: Life Science. Richardson, 1979, p. 479.

OBJECTIVE: To apply the laws of probabilities to chance happenings

TITLE: "Chance Happenings"

SOURCE: Life Science. Richardson, 1979, p. 488.

OBJECTIVE: To apply Mendel's Laws in tracing the inheritance of a specific human characteristic

TITLE: "The Family Pedigree"

SOURCE: A Sourcebook for the Biological Sciences. Morholt, et al., 1966, p. 384.

OBJECTIVE: To apply Mendel's Laws and the test cross in the identification of an unknown genotype

TITLE: "Punnett Square, Probabilities, and the Stomper-Glompers"

SOURCE: Teacher developed by Celeste Fender

OBJECTIVE:	To identify the processes and results of reduction division
TITLE:	"Meiosis and Probability Investigation"
SOURCE:	Teacher developed by Celeste Fender
OBJECTIVE:	To apply laws of genetics and probability to a practical problem
TITLE:	"Selective Breeding"
SOURCE:	Interaction of Man and the Biosphere. Abraham.
OBJECTIVE:	To analyze change data indicative of a trend
TITLE:	"A Horse, Is a Horse, Is a Horse"
SOURCE:	ISS Biology. Wong and Dolmatz, p. 81.
OBJECTIVE:	To analyze real-life situations to establish the degree of diversity within a species
TITLE:	"Variety Is the Spice of Life"
SOURCE:	IIS Biology. Wong and Dolmatz, p. 91.

Text Materials

Abraham, Norman, et al. Interaction of Man and the Biosphere. Rand McNally and Company, 1970.

Bernstein, Leonard, and Schachter, Martin. Concepts and Challenges in Life Science. Cebco Standard Publishing, 1979.

Brandwein, Paul F. Life -- Its Forms and Changes. Harcourt, Brace, and Jovanovich, 1972.

Morholt, et al. A Sourcebook for the Biological Sciences. Harcourt, Brace, and World, Inc., 1966.

Richardson, Jenne Taylor. Life Science. Silver Burdett, 1979.

Wong, Harry K., and Dolmatz, Malvin S. Biology -- Ideas and Investigations in Science. Prentice-Hall, Inc.

Films -- Hastings Library

Cell Division

Heredity

Film Loops -- Hastings Library

Mitosis

Exemplary Activity
Grade 7
Life Science
Unit: Heredity and Evolution

OBJECTIVE: To identify the processes and results of reduction division

MATERIALS AND EQUIPMENT: See Procedure

PROCEDURE:

Divide yourselves up into groups of two. Each group will be given the ditto, "Parent."

1. Each group will begin by having one pair of like chromosomes in the germ cell (long red, long red).

   What will the sex cells produced by this cell contain?

   Note: The sex cells have 1/2 the normal number of chromosomes. The sex cells receive one chromosome from each pair of chromosomes.

2. Now the parents will have 2 pairs of like chromosomes in the germ cell (2 long red, 2 long blue).

   Now what will the sex cells contain?

   Note: The color of the chromosomes tells which pair they belong to.

3. Now the parent will have 2 pairs of unlike chromosomes in the germ cell (short red, long red, short blue, long blue).

   Now how many different kinds of sex cells can be made by this germ cell? List the possible combinations.

   If it is equally likely that any one of these could be produced, then the probability of producing one is ____.

   The formula for determining the number of different kinds of sex cells that can be produced is 2^n where n = the number of unlike pairs of chromosomes.

   Note: The length tells whether they are like or unlike chromosomes.

   Thus, if there are 2 pairs of unlike chromosomes, the formula becomes 2^2, and $2^2 = 4$.

4. Now the parents have 3 pairs of unlike chromosomes (short red, long red, short blue, long blue, short green, long green.)

   Now how many different kinds of sex cells can be made? List the possible combinations that can be made.

   What is the probability of producing any one of these? ____

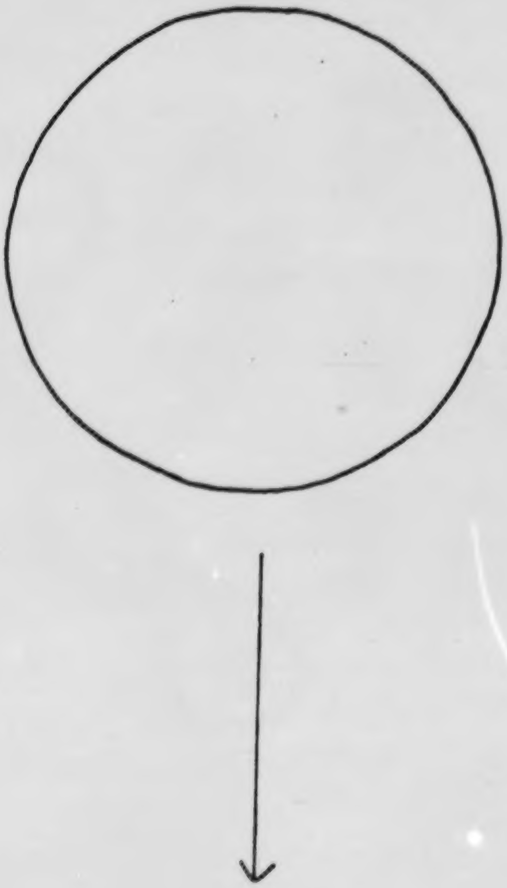
PARENT

*Color = chromosome pair

*Length = dominant or recessive genes on the chromosome

Germ Cell

(produces sex cells)



Possible Sex Cells
(receive one chromosome from each pair)

OBJECTIVE: To apply Mendel's Laws and the test cross in the identification of an unknown genotype

MATERIALS AND EQUIPMENT: See Procedure

PROCEDURE:

In this lab you will be working with the chromosomes of a very simple animal called a "stomper-glomper" (a very rare and endangered species). "Stomper-glompers" are usually bright purple but once in a while, one will turn up a hot pink color. NOTE: These are extremely rare; not only are they a different color, but they usually behave differently from your run-of-the-mill purple stomper-glomper. In other words, BEWARE! Don't run around barefoot on warm summer nights as they enjoy eating children's toenails for bedtime snacks.

Purple stomper-glompers are usually more desirable to breed because after they mature they grow silver (real silver) warts on their backs. So if you can find 2 purebred purple stomper-glompers, you could make your fortune and quit school! The problem is: How do you know if you have a purebred purple stomper-glomper??? Actually, there are several ways you can find out......

1. The first way (and the easiest) is to cross the purple stomper-glomper in question with a pink stomper-glomper. Since pink stomper-glompers have to have 2 recessive genes in order to be pink, they will always be purebreds. What is its genotype? ________________

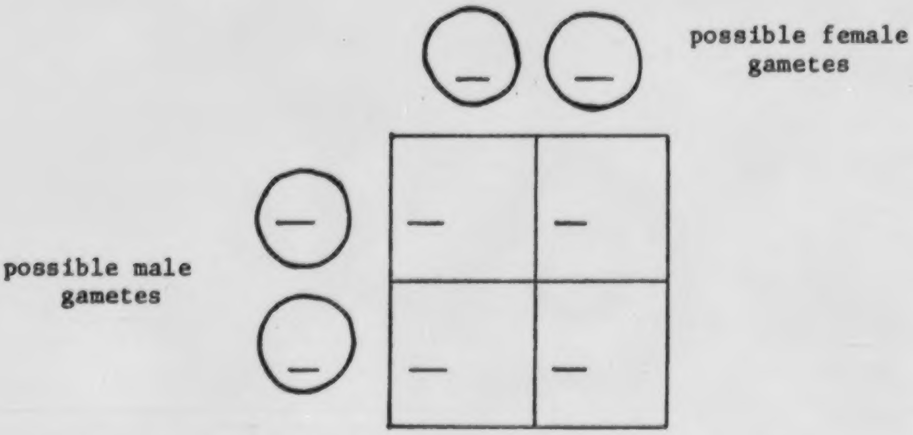
   IMPORTANT: Any organism that shows a recessive trait will always be a purebred for that trait. Why?
   EXAMPLES: Dwarfism in pea plants or albinism in guinea pigs

   Pretend your purple stomper-glomper is a purebred also. What is his genotype? __________ Do purebreds have like or unlike chromosome pairs? __________ On your Punnett square handout (NOTE: This is to be used for all classes so please don't write on it), place the genotype of the purple stomper-glomper on the left side of the Punnett square in the parent or germ cell. Next, the parent cell will undergo a special type of cellular division. What is the proper name for this division? __________ Is it sexual or asexual? __________

   Now your stomper-glomper chromosomes should be in the smaller circles, which represent the possible gametes. How many chromosomes are in each of these possible gametes? ____ What is the probability of obtaining either one of these possible gametes? (in fraction form) _______

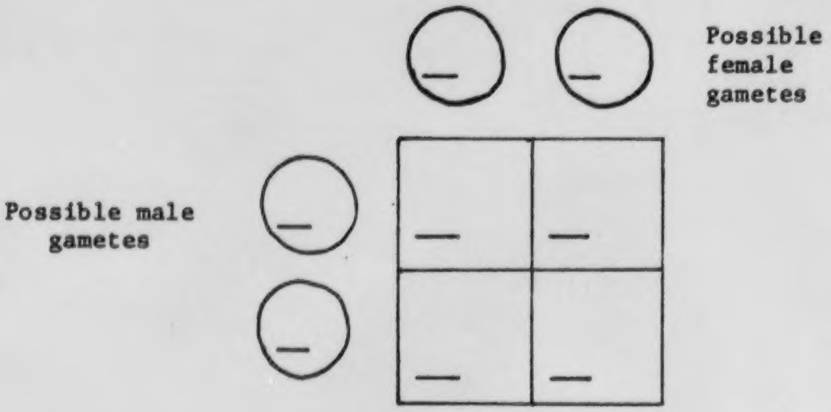
Meanwhile, back at the ranch (or stomper-glomper breeding farm, if you prefer), your hot pink stomper-glomper is feeling very neglected and left out of the picture, so place her in your picture (handout) inside the parent cell at the top of the page. Now her __________cells undergo a special type of division that separates the chromosome pairs. What is the proper name of the daughter cells that are the product of this division? ________ What is the probability of obtaining either one of the possible gametes? (in fraction form) ______________

Fill in the Punnett square by moving your chromosomes to the appropriate boxes. Record your results in the diagram below. Include the probabilities (in fraction form) you obtained on the lines provided.



Are the baby stomper-glompers hybrids or purebreds? __________________
Are they homozygous or heterozygous? __________________ Will they grow up to produce silver warts? ________

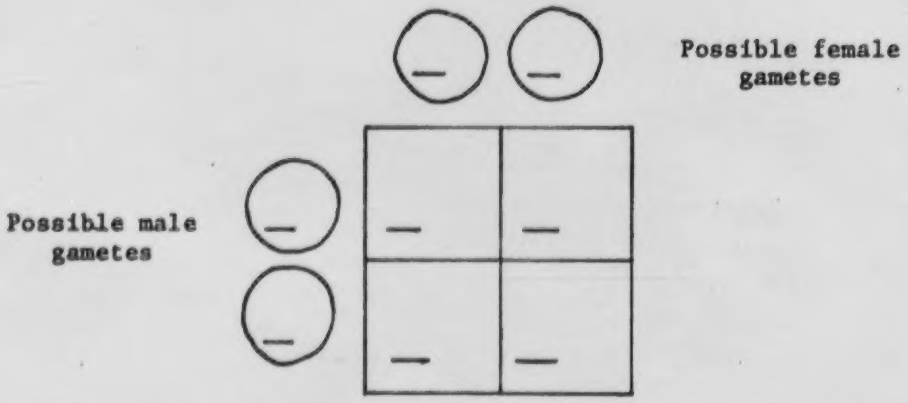
2. Now we're going to try another test cross. This time the purple stomper-glomper is heterozygous, which means he's a ___________________ (purebred or hybrid). We're going to cross-breed him to the same pink stomper-glomper in #1. Start by placing the chromosome pairs in their proper germ cells and then follow the same procedures used in #1 to divide the chromosome pairs and to fill in the Punnett square. Record your results on the next page and include the probabilities on the lines provided.


Possible female gametes
Possible male gametes

Are the baby stomper-glompers hybrids or purebreds? ____________ Are they homozygous or heterozygous? ____________ What are their genotypes? ____ How many are purple? ______ How many will grow up and produce silver warts? _____

3. There is a shortage of pink stomper-glompers (this happens if they eat too many dirty toenails). So this time cross the "mystery" purple stomper-glomper with another known purple stomper-glomper (the one in #1). The offspring are all purple. What do you suppose the genotype of the "mystery" stomper-glomper was? ________________ Can you be sure? ______ Why or why not?

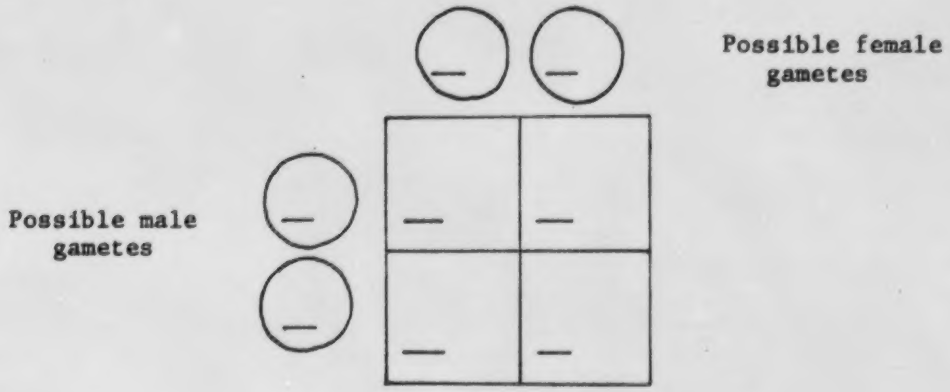
Record your results below and include the probabilities on the lines provided.


Possible female gametes
Possible male gametes

How many of your baby stompers are purple? ______ How many are pink? ________ How many are homozygous? ________ How many are heterozygous? ___________

4. There is still a shortage of pink stomper-glompers (remember ecology and wildlife preservation begin at home, so clean those toenails!). This time cross the mystery stomper-glomper with the known purple stomper-glomper from #2. One of the offspring is pink! So what must be the genotype of the mystery stomper-glomper? ____________ How do you know this?

Show the results of this test-cross below and include the probabilities (in fraction form) on the lines provided.



How many of the offspring (baby stomper-glompers) are purebred? _____
How many are hybrids? ____ How many are purple? ____ How many will grow silver warts? ____

OBJECTIVE: To apply laws of genetics and probability to a practical problem

MATERIALS AND EQUIPMENT: For each team -- 16 black faced cards (heavy), 16 red faced cards (light)

PROCEDURE:

A. The ancestral horse probably had many genes to control the trait of body form. In this game we will consider two genes for body form. Each parent, the mother and father, contributes one gene to the offspring, giving a total of two genes for body form. The two different genes in this game for body form will be heavy and light.

B. The class will be divided into teams of 4 students each.

C. Each student will receive 4 cards marked heavy and 4 cards marked light.

D. Each team will be assigned a type of horse to develop (draft or light horse).

E. To begin, each player on a team will place all of his/her cards in the center of the table, face down, and one player will shuffle them thoroughly. Then the cards should be dealt two at a time to each player until all of the cards are gone. The shuffling represents the genes present in a herd of horses. The dealing represents the combination of genes in the offspring. (Each offspring gets one gene from each parent.)

F. The cards should then be placed face up in pairs. Different gene combinations produce different visible appearances of the horse.

1. 2 heavy cards = draft horse
2. 1 heavy card and 1 light card = medium horse
3. 2 light cards = light horse

G. Record the number of each kind of offspring in the table.

H. The members of each team should decide which offspring should be put back into the herd of horses to be bred to produce the kind of horses they are trying to develop. The cards for the offspring not to be mated should be removed from play.

NOTE: Medium horses cannot be removed from play. Why?

I. Each player places the cards representing the offspring he/she wants mated face down in the center of the table and one player will shuffle them. The cards are then dealt out two at a time to each player until they are gone.

J. Repeat procedures G - I until all of the offspring in a generation are the kind of horse your team is trying to develop.

K. One member of each team will report to the class what procedures his/her team used in developing their particular type of horse.

The object of this game is to see which team can develop a herd of one type of horse in the fewest generations through selective breeding.

	Draft Horse	Medium Horse	Light Horse	Number and type of horse removed from breeding stock
FIRST GENERATION				
SECOND GENERATION				
THIRD GENERATION				
FOURTH GENERATION				
FIFTH GENERATION				
SIXTH GENERATION				

Evaluation Sample
Grade 7
Life Science
Unit: Heredity and Evolution

GENETICS TEST

Put the number of the most correct answer in the blank provided.

______ heterozygous

______ cell division producing an egg as a daughter cell

______ genetic makeup of an individual

______ researcher in genetics

______ homozygous

______ number of chromosomes in a human germ cell

______ "hidden" gene

______ cell division producing growth

______ the study of how traits are inherited

______ dominant gene

______ the passing of a trait from one generation to the next

______ outward appearance caused by the genetic makeup

______ sex cell

______ structure in a cell nucleus carrying the heredity trait

______ an organism with two of the same genes for one trait

1. Gregor Mendel
2. 46
3. mitosis
4. purebred
5. R
6. chromosomes
7. 23
8. gamete
9. heredity
10. genotype
11. meiosis
12. purebred
13. genetics
14. recessive
15. hybrid
16. phenotype
17. Max Ross

True or False (Write + or 0 in the blank provided.)

______ Humans have more chromosomes than any other living organism.

______ If a germ cell has six chromosomes in it, it will produce three daughter cells.

______ Germ cells are located in sex organs.

______ We were once composed of one cell.

Multiple Choice. Put the letter of the most correct answer in the blank.

______ ? are responsible for the inheritance of a trait.

- a. eggs
- b. genes
- c. sperm
- d. gametes

______ During fertilization of a flower, the fertilized egg obtains 1/2 the chromosomes from the egg cell and 1/2 the chromosomes from the ? .

- a. petal
- b. stigma
- c. pollen
- d. pistil

______ Gregor Mendel worked with pea plants because pea plants have ? .

- a. multiple offspring
- b. trait either present or absent (no blending)
- c. complete reproductive cycle in a year
- d. all of the above

______ Mendel hypothesized the yellow trait was more "powerful" than the green trait. Therefore, we now say the yellow trait is ? .

- a. recessive
- b. absent
- c. dominant
- d. hidden

______ For any trait in a pea plant, it has at least ? genes.

- a. one
- b. two
- c. three
- d. four

______ The cross between two hybrid (first generation offspring) can be predicted. This ratio is ? .

- a. 1:1
- b. 2:1
- c. 3:1
- d. 3:2

______ The sex cell has what fraction of the number of chromosomes in the germ cell?

- a. 1/4
- b. 1/2
- c. 1/8
- d. 1/1

______ By what process are the daughter cells produced identical to the parent cell?
    a. meiosis
    b. mitosis
    c. fertilization

Complete the following:

Cross a pure purple stomper-glomper with a pink stomper-glomper.

___ ___ X ___ ___ (1 point)

	___	___
___		
___		

(1 point)

______ How many baby stomper-glompers are hybrids?

______ How many baby stomper-glompers are pink?

Cross a hybrid tall pea plant with a pure tall pea plant.

___ ___ X ___ ___ (1 point)

	___	___
___		
___		

(1 point)

__________ What is the genotype fraction?

__________ What is the phenotype fraction?

______ How many are homozygous?

______ How many are heterozygous?

NOTE: Show fractions when you do the crossing in the Punnett squares!

Evaluation Sample (Cont.)
Grade 7
Life Science
Unit: Heredity and Evolution

EVOLUTION QUIZ

1. What Era are we presently in? ________________

2. What was the first type of plant to appear on land? (Circle one)

   a. ferns
   b. conifers
   c. moss
   d. crinoids

3. If we measured the diameter of coconuts and graphed our data, what kind of graph would result?

   ____

4. In the Manchester Forest, trees began to turn dark. White moths, seeing this change, turned black. TRUE FALSE (Circle correct answer)

5. Eohippus ("dawn-horse") had ____ toes on its front legs and ____ toes on its back legs.

6. Arrange the following in order of youngest to oldest on the geologic time scale. (Worth 2 points)

   a. man
   b. dinosaurs (reptile)
   c. blue-green algae
   d. trilobite
   e. starfish
   f. ginkgo

   youngest ____________________
   ↑ ____________________
   time ____________________
   ____
   ____
   oldest ____________________

7. Physical change is the only way an animal evolves. TRUE FALSE

8. A species of birds lives on an island. The main source of food for the birds is berries. Also on the island there are nut trees. (Some of the birds can use the nuts for food.) If man came to the island and used most of the berry trees to build houses, what do you think would happen to the bird population? Explain your answer. (Worth 2 points)

9. **What part of an animal usually fossilizes?**

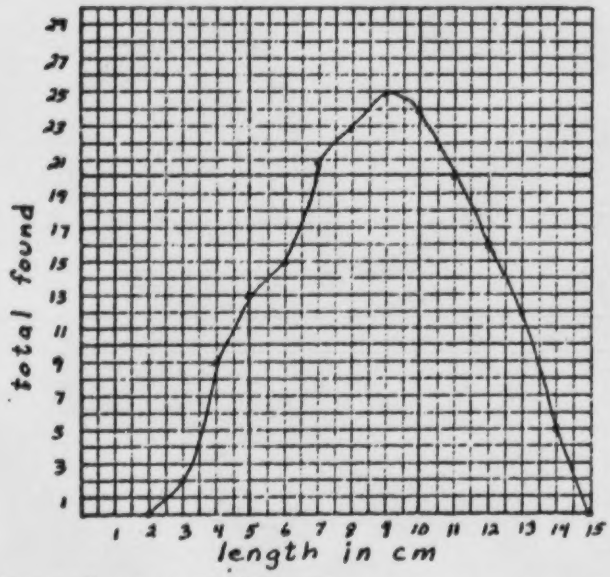
   a. hair
   b. skin
   c. internal organs
   d. bones

10. What kind of fossil did Dr. Barghoorn find that he thinks sets back the date of the first life on the earth by 100 m.y.? ____________________

11. Mr. Spock measured the length of Tribbles aboard the Enterprise. (Tribbles are little furry animals that are about as big as your fist.) His data is recorded below. Graph the data on the blank graph given below.

Spock's Data

length in cm.	2	3	4	5	6	7	8	9	10	11	12	13	14	15
total found		2	9	13	15	21	23	25	24	20	16	12	5	



What is the shape of your graph? ______________________________

Evaluation Sample (Cont.)
Grade 7
Life Science
Unit: Heredity and Evolution

EVOLUTION QUIZ 2

Matching. Select the number of the BEST answer and place it in the space provided.

______ main divisions of the earth's past, determined by changes in the physical features of the earth and the dominant life forms

______ an example of a plant adaptation that made life on dry land possible

______ how we can tell the age of a horse

______ name for all of the "horse-like" creatures on the earth today

______ one of the reasons why evolution occurs

______ the first "horse-like" inhabitant of the world

______ any structure or behavior that makes survival possible

______ change over very long periods of time

1. evolution
2. eras
3. Eohippus
4. Merychippus
5. Equus
6. periods
7. natural selection
8. wear of the teeth
9. adaptation
10. roots

True or False. Use a plus (+) for true and a zero (0) for false.

______ Simple forms of plant life evolved from more complex forms.

______ All of the members of a species are the same in every respect.

______ Living things come from other living things.

______ All organisms are related.

______ The most complex forms of plant and animal life are the dominant ones today.

______ An organism can adapt to a changing environment. It can grow whatever structures are needed for survival.

______ Horses are born with a full set of permanent teeth.

______ Living things have a long history.

Multiple Choice. Select the number of the best answer and place it in the space provided.

______ Which of the following is not a gymnosperm?
1. pine tree
2. ginkgo
3. sago palm (cycad)
4. maple tree

______ Which of the following is a behavioral adaptation of the horse?
1. the tendency to group together in herds
2. one toe on each foot
3. stronger tooth structure
4. larger eyes

______ The webbed feet of a duck are an adaptation for:
1. stomping on grapes
2. turning pages
3. climbing trees
4. typing on a typewriter
5. swimming

______ Where did the ancestors of the horses we see today come from?
1. Asia
2. North America
3. South America
4. Arabia

______ Which of the following is not one of the changes that occurred during the evolution of the horse?
1. went from many toes to one toe per foot
2. became smaller
3. became longer legged
4. developed larger teeth

. . . .

Arrange the geologic eras from most recent to oldest.

1. Paleozoic
2. Cenozoic
3. Archeozoic
4. Proterozoic
5. Mesozoic

most recent ____________________

____

____

____

oldest ____________________

Evaluation Sample (Cont.)
Grade 7
Life Science
Unit: Heredity and Evolution

______ During which era did the mammals come into existence as the dominant life form?

______ During which era were the angiosperms the dominant plant type?

______ Which era is called the "age of reptiles?"

. . . .

Answer the following questions pertaining to the plant types.

Arrange the following plant types from simplest to most complex:

1. angiosperm
2. fern
3. moss
4. algae
5. gymnosperm

simple ______________
____
____
____
complex ______________

______ A pine tree is an example of a/an _?_.

______ An oak tree is an example of a/an _?_.

______ "Flowers: seeds inside a fruit" describes the _?_.

______ "Unprotected seeds: usually have cones and needle-like leaves" describes the _?_.

______ Which are the most successful land plants?

. . . .

Arrange the following animal types from "appeared first" to "appeared last."

1. mammals
2. amphibians
3. fish
4. reptiles
5. one-celled aquatic animals

first ______________
____
____
____
last ______________

. . . .

The following statements pertain to the research we did when we checked the a.m. and p.m. temperatures of part of the House 7-C population. Circle the number(s) of the statement(s) that our research proved to be true.

According to our results, we found that:

1. The human body temperature never changes.
2. Most people have a body temperature that is somewhere between the few whose temperature is lower and the few whose temperature is higher.
3. The human body temperature is usually higher in the morning than it is in the evening.
4. The human body temperature is usually lower in the morning than it is in the evening.
5. Humans have a higher body temperature than horses.

Unit Outline
Grade 7
Life Science
Unit: Treatment of Data

I. Observations

   A. Observations and inferences
   B. Collection of data
   C. Construct data tables and graphs

II. Perceptions Based on Senses

   A. Eye function
   B. Sensory interpretation

III. Perceived World Vs. Physical World

   A. Perceptions and facts are not always the same.
   B. Resolve ambiguous perceptions by measurement or logical reasoning.

IV. Perception Depends on Past Experience

   A. Inductive reasoning
   B. Deductive reasoning

V. Hypothesizing

   A. Formulate hypothesis from data.
   B. Judge acceptability of hypothesis.

Suggested Activities
Grade 7
Life Science
Unit: Treatment of Data

OBJECTIVE: To communicate observations to others in writing; to have the accuracy of the observations confirmed

TITLE: "What Can You Observe About People?"

SOURCE: Educational Research Council of America. Man and the Environment. Boston: Houghton Mifflin Co., 1971, pp. 14 and 29.

OBJECTIVE: To seek and collect quantitative observations in studying natural phenomena

TITLE: "How Fast Does Your Heart Beat?"

SOURCE: Educational Research Council of America. Man and the Environment. Boston: Houghton Mifflin Co., 1971, pp. 21, 26, 33.

OBJECTIVE: To construct data tables and graphs

TITLE: "How Do You Collect and Record Data?"

SOURCE: Carter, Goodman, Hunter, Schelske. Life Science: A Problem-Solving Approach. Boston: Ginn and Co., 1971, pp. 9, 28, 79.

OBJECTIVE: To predict that new perceptions will result when there is a new sensory input

TITLE: "How Do Animals Get Information?"

SOURCE: Educational Research Council of America. Man and the Environment. Boston: Houghton Mifflin Co., 1971, p. 36.

Carter, Goodman, Hunter, Schelske. Life Science: A Problem-Solving Approach. Boston: Ginn and Co., 1971, p. 5.

OBJECTIVE: To realize that perceptions and facts are not always the same thing

TITLE: "How Reliable Are Your Senses?"

SOURCE: Educational Research Council of America. Man and the Environment. Boston: Houghton Mifflin Co., 1971, pp. 42,44, 46, 47.

OBJECTIVE: To resolve ambiguous perceptions by measurement and logical reasoning

TITLE: "Mapping Pressure Receptors"

SOURCE: Abraham, Berdleman, Moore, Moores, Utley. Interaction of Man and the Biosphere. Chicago: Rand McNally and Company, 1970, pp. 115, 117, 118.

Navarra, Zafforoni, Garone. Life and the Molecule. New York: Harper and Row, 1970, pp. 17, 34, 36.

OBJECTIVE: To predict that different people will perceive the same object in different ways

TITLE: "Does Everyone Perceive the Same Way?"

SOURCE: Educational Research Council of America. Man and the Environment. Boston: Houghton Mifflin Co., 1971, pp. 50-51, 54-57.

OBJECTIVE: To formulate hypotheses from a table of data

TITLE: "How Long Can a Person Hold His Breath?"

SOURCE: Educational Research Council of America. Man and the Environment. Boston: Houghton Mifflin Co., 1971, pp. 65, 68.

OBJECTIVE: To be able to support, reject, or prove that a hypothesis is inconclusive

TITLE: "Why Do Some Animals' Hearts Beat Faster Than Others?"

SOURCE: Educational Research Council of America. Man and the Environment. Boston: Houghton Mifflin Co., 1971, pp. 75, 76.

Resources
Grade 7
Life Science
Unit: Treatment of Data

Text Materials

Abraham, Berdleman, Moore, Moores, Utley. *Interaction of Man and the Biosphere*. Chicago: Rand McNally and Company, 1970.

Bernstein, Leonard, and Schachter, Martin. *Concepts and Challenges in Life Science*. Cebco Standard Publishing, 1979.

Brandwein, Stollberg, Greenstone, Yasso, Brovey. *Life -- Its Forms and Changes*. New York: Harcourt, Brace, Jovanovich, Inc., 1972.

Carter, Goodman, Hunter, Schelske. *Life Science: A Problem-Solving Approach*. Boston: Ginn and Company, 1971.

Educational Research Council of America. *Man and the Environment*. Boston: Houghton Mifflin Company, 1971.

Navarra, Zafforoni, Garone. *Life and the Molecule*. New York: Harper and Row, 1970.

Richardson, Jenne Taylor. *Life Science*. Silver Burdett, 1979.

Exemplary Activity
Grade 7
Life Science
Unit: Treatment of Data

OBJECTIVE: To formulate a hypothesis from data

MATERIALS AND EQUIPMENT: Teacher-developed transparencies

PROCEDURE:

Have a class discussion resulting in the formulation of hypotheses from data.

Transparencies (teacher developed):

1. Relationship between heart temperature of fish and heartbeats per minute
2. Relationship between maximum number of offspring in one year and gestation period
3. Relationship between heartbeats per minute and longevity

Evaluation Sample
Grade 7
Life Science
Unit: Treatment of Data

Name ______________________________________

A farmer wanted to see if he could increase the yield of his corn crop by spraying with an insecticide. Twenty acres were divided in half. Ten acres in plot A were sprayed. Ten acres in plot B were left at ordinary conditions.

1. Which group is the control group?

2. Which group is the experimental group?

3. What is the experimental factor?

Some teenagers wanted to see if rock music would affect the growth of plants. Ten plants in group X were put in a room under ordinary conditions. Ten plants in group Y were put in a room where rock music was played continually.

1. Which group is the control group?

2. Which group is the experimental group?

3. What is the experimental factor?

What are the 5 steps in the scientific method of solving problems?

1.

2.

3.

4.

5.

A student had a pet hamster. While caring for his animal, the student became interested in the amount of daily activity shown. He decided to use a meter to measure how many times the hamster rotated its exercise wheel. He read the meter every day for six days. On the first day the hamster turned the wheel 98 times. The second day the hamster turned the wheel 84 times. The third day the hamster turned the wheel 92 times. The fourth day the hamster turned the wheel 64 times. The fifth day the hamster turned the wheel 72 times. On the final day the hamster turned the wheel 80 times.

Use the grid on the next page to organize the above data in a logical fashion.

Evaluation Sample (Cont.)
Grade 7
Life Science
Unit: Treatment of Data

Data Table:

Write Fact or Belief in the blank.

________ 1. It snows the most in the month of December.

________ 2. Sarah got an A on the spelling test.

________ 3. Gasoline prices are going up.

________ 4. Short people make the best teachers.

Write the 5 steps of the scientific method of problem solving, in order.

1. ______________________________

2. ______________________________

3. ______________________________

4. ______________________________

5. ______________________________

Write O for observation and I for inference.

________ 1. One chair is blue and one is orange.

________ 2. The blue chair is more comfortable than the orange chair.

________ 3. The orange chair has something black on the seat.

________ 4. Both chairs were purchased at the same time.

________ 5. Both chairs are in room 216.

____

________ 1. One sack is from the Big Bear store.

________ 2. One sack is torn.

________ 3. Both sacks belong to Mrs. Williams.

________ 4. Mrs. Williams carried groceries in both sacks.

________ 5. One sack has red printing and the other has brown printing.

1. When going from a dark room into a bright room, what happens to the pupil of the eye?

2. What is a stimulus?

3. What is the function of the iris of the eye?

____ 4. When the light becomes brighter, the pupil becomes (a) larger (b) smaller.
____ 5. The back of the tongue is most sensitive to (a) sweet (b) sour (c) salt (d) bitter.
____ 6. The tip of the tongue is most sensitive to (a) sweet (b) sour (c) salt (d) bitter.
____ 7. When pressure receptors are closer together, that area of the skin is (a) more (b) less sensitive.
____ 8. The sensitive inner lining of the eye that reflects the image is called (a) pupil (b) retina (c) lens (d) iris (e) optic nerve.
____ 9. When you concentrate on looking at something for a period of time and then look away but still see the image, it is called (a) optical illusion (b) afterimage.
____ 10. The more sensitive something is, the (a) more (b) less it reacts.

Someone set off a stink bomb in the hallway.

____ 1. The small was the (a) stimulus (b) receptor.
____ 2. The nose was the (a) stimulus (b) receptor.

Evaluation Sample (Cont.)
Grade 7
Life Science
Unit: Treatment of Data

Someone pinched my arm.

____ 1. The part of my arm that was pinched was (a) stimulus (b) receptor.
____ 2. The pressure on my arm was (a) stimulus (b) receptor.

1. Formulate a hypothesis from the data given below.

STUDY TIME AND GRADES

Grades on spelling test	E	D	C	B	A
Study time in minutes	0	15	20	25	30

Hypothesis: ____

____

From the data given below, tell whether the hypotheses are true or false.

Teachers	Donuts	Apples
Mrs. Williams	0	1
Mrs. Klingensmith	1	1
Mrs. Woodard	2	1
Mrs. Goldsmith	3	1
Mr. Kent	3	2
Mr. Trainer	2	1
Mr. Shook	1	0

____ 1. Most teachers do not eat donuts for breakfast.
____ 2. Women teachers eat more donuts than men teachers.
____ 3. Teachers eat more donuts than apples for breakfast.
____ 4. Mr. Kent eats more donuts and apples for breakfast than anyone.

Student	Sleeping Hours	Snacks
John	8	1
Jack	7	1
Tim	9	4
Bill	8	2
Sarah	10	1
Susan	10	1

____ 1. Boys eat more snacks than girls.
____ 2. Boys sleep more hours than girls.
____ 3. Girls sleep more hours than boys.
____ 4. Tim sleeps more and eats more snacks than anyone.
____ 5. Those who sleep more than 8 hours eat more snacks than those who sleep 8 hours or less.

Unit Outline
Grade 8
Earth Science
Unit: Using Data

I. Arranging and Treating Data

   A. Organizing obtained data by constructing graphs and tables
   B. Detecting patterns in given data presented in tables and graphs
   C. Computing or identifying the mean, median, and range for a given set of data

II. Interpreting Data

   A. Using the processes of inferring and predicting to interpret the data collected by drawing warranted generalizations from a body of data
   B. Detecting trends in data to predict by interpolation and extrapolation
   C. Determining whether generalizations made by others are supported by data

OBJECTIVE: To obtain and organize data about several subjects including student heights, perception, and light effects on pupil size

TITLE: "Getting It All Together"

SOURCE: Modified activities from Wong, Harry, and Dolmatz, Malvin. Biology: Ideas and Investigations in Science. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1971.

OBJECTIVE: To construct and interpret graphs relating speeds, distances, and periods of planets

TITLE: "Wanderers"

SOURCE: Modified activities from Atkin, J., and Wyatt, Jr., S. The Universe in Motion. University of Illinois Astronomy Program. New York: Harper and Row, 1969.

OBJECTIVE: To measure learning in humans by using student-constructed mazes

TITLE: "Amazing"

SOURCE: Modified activities from Rasmussen, F.; Holobinko, P.; and Showalter, V. Man and the Environment. Boston: Houghton-Mifflin, 1971.

OBJECTIVE: To analyze data and detect trends using information to locate earthquake epicenters

TITLE: "Shaking It Up"

SOURCE: Modified activities from Eisler, Sanford; Stock, Murray; and Disantis, Paul. Changes in the Earth's Crust, Lab Inquiry Texts: Earth Science. New York: Cambridge Book Company, 1973.
Earthquake Watch, Hastings Junior High School resource file.

Suggested Activities (Cont.)
Grade 8
Earth Science
Unit: Using Data

OBJECTIVE: To collect, organize, and interpret data

TITLE: "The Teenage Pulse"

SOURCE: From Science Staff of Educational Research Council of America. Introduction to Individualized Science Investigations (Phase A). Boston: Allyn and Bacon, Inc., 1974.

Text Materials

Hermann. Test on Graphing and Graph Interpretation Skill. Ohio State University.

Process of Science Test. Biological Sciences Curriculum Study, Psychological Corporation, New York.

Films

Graphs -- Understanding and Using Them. Coronet, Indiana University.

Mean, Median, and Mode. McGraw-Hill, Indiana University.

Games/Simulations

"Certainly...Well, Maybe," Educational Research Council of America, Cleveland.

Exemplary Activity
Grade 8
Earth Science
Unit: Using Data

OBJECTIVE: To generate data and present that data graphically

MATERIALS AND EQUIPMENT: Rulers, meter sticks, graph paper

PROCEDURE:

Graphs are important because:

a. They help organize data.
b. They make it easier to interpret data.
c. Predictions can be made based on their data.

There are many kinds of graphs. We will be concerned with only three kinds: histograms, bar graphs, and line graphs.

You have all made tally marks. You frequently use the tally system to keep track of votes in a class. A histogram can be used to keep track of tally marks, too.

Measure the height of one other person in your class, then trade positions. The measurements will now be collected for all the students.

1. What brief, but complete, title should be used to describe your results? Put the title on the line above the histogram.

   Remember what has been stressed. Know what you are doing before you start. Measuring the heights of the students will be the easiest task. What are you going to do with the measurements?

   There are four rules you must follow in making a histogram. These rules will apply to a type of graph paper with lines drawn on it to form grids.

   a. Draw a box with lines in it to form grids that are equally spaced.
   b. Use a pattern of numbers that is consecutive, that is, does not skip in the order or pattern of the numbers.
   c. Label each side of the grid to indicate what the numbers stand for.
   d. Indicate the units for each side of the grid.

The histogram will be used to compare two sets of numbers.

a. The heights of the students. These numbers are listed across the bottom (horizontal) side of the grid.
b. The number of students for each height. These numbers are listed along the vertical side of the grid.

The possible heights of the students are listed across the bottom line. Find out who is the shortest and who is the tallest person in the class. List the span of heights from the shortest to the tallest person across the bottom side of the grid. List each height under a column, that is, between the vertical lines.

The possible number of students (for each height) are listed along the vertical side of the grid. Although you do not have to do so, it is customary to begin with zero or one. List the span of numbers along the vertical side of the grid between the lines.

Now we are ready to start. As the height of each of the students is measured, make an "x" for a tally mark in the square above the proper height.

2. According to the data in your histogram, what is the most common height in the class?

   If you were to look at all the students in your class, it would be very difficult to determine the most common height. If you make a histogram, the task is easier.

3. How does a graph help an experimenter?

Evaluation Sample
Grade 8
Earth Science
Unit: Using Data

Unit Test

Name ______________________________

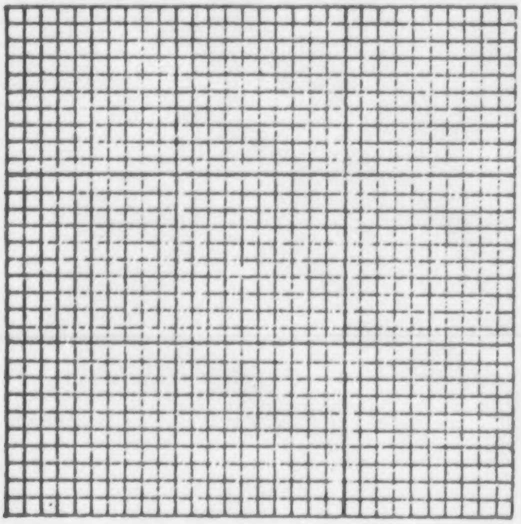
A. Below is a table showing the temperature of water at various time intervals as the water is heated.

Time Intervals in Minutes	0	1	2	3	4	5	6
Celsius Degrees	44	70	94	98	100	100	100

1. Identify the range for the above data.

2. Compute the mean temperature for the above data.

3. Graph the above data on the graph provided below. (Make a line graph.)

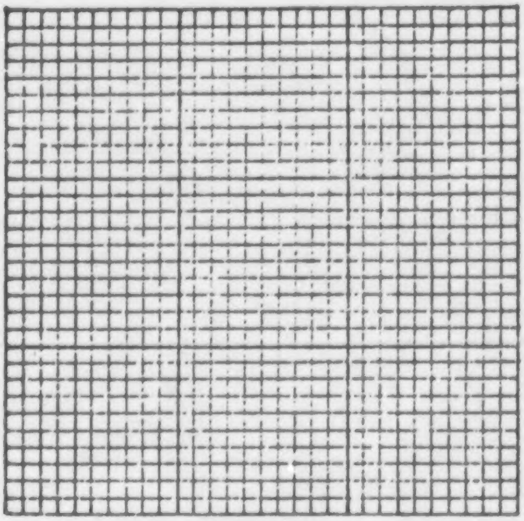


4. Use the above graph to predict the temperature of the water after ten minutes of heating.

B. In an experiment on heat conduction, four marbles were attached to an aluminum rod with a small piece of wax. The marbles were spaced evenly apart (2 centimeters). The rod was then placed into a flame exactly two centimeters from the first marble. The time for each marble to fall from the rod was recorded. The experiment was repeated for a steel and a brass rod. The data is presented on the next page.

Marble number	Distance from flame (centimeters)	Time to drop (seconds)		
		Aluminum	Brass	Steel
1	2	9	10	7
2	4	17	33	23
3	6	29	75	44
4	8	45	145	62

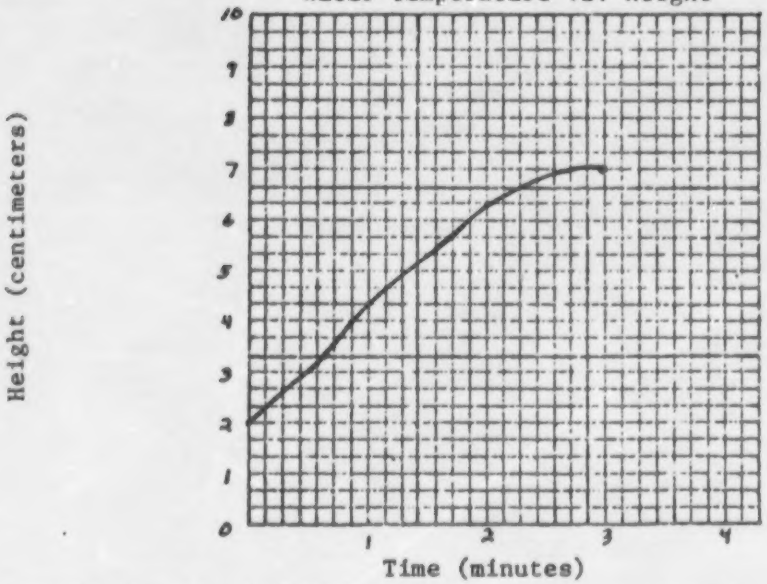
5. Construct a line graph to show the above data.



6. Make one conclusion based on the above data.

C. In an experiment on the expansion of water, a student recorded the changing heights of a water column that was slowly rising from being heated. The height was recorded every thirty seconds and a complete graph of the data is shown on the next page.

Water temperature vs. height

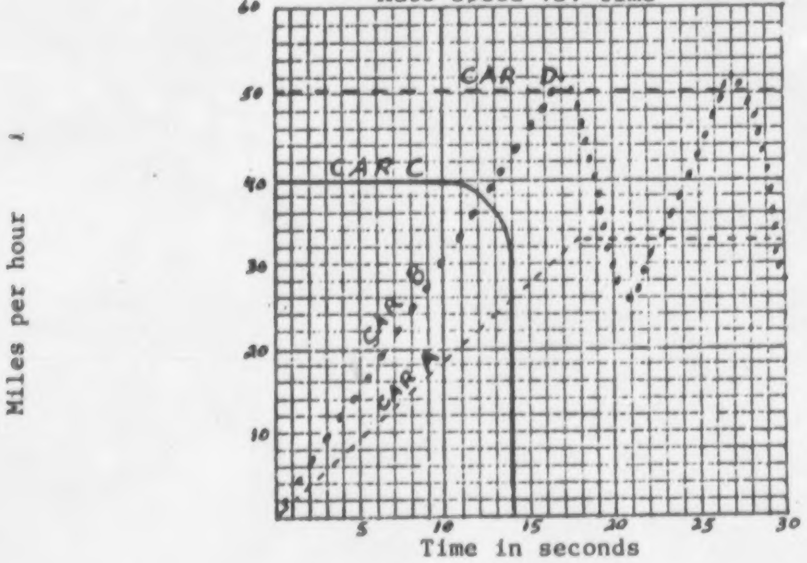


7. Predict the height of the water at the time of 1 6/7 minutes from the start of the timing. Circle your choice.

A. 5.6 cm
B. 5.8 cm
C. 6.0 cm
D. 6.3 cm

D. Below is a graph describing the motion of four automobiles. Answer each of the questions on the next page, and explain the reason why you chose your answer.

Auto speed vs. time



8. Which car traveled at a constant rate of speed? ____________
What was its speed? ___________
Reason for answers:

9. Which car seemed to have suddenly stalled? _________
How long after it started to move did it stall? _________
Reason for answers:

10. Which car started from a stopped position, gradually increased its speed to 33 miles per hour, and then kept traveling at the same speed? _______________
Reason for answer:

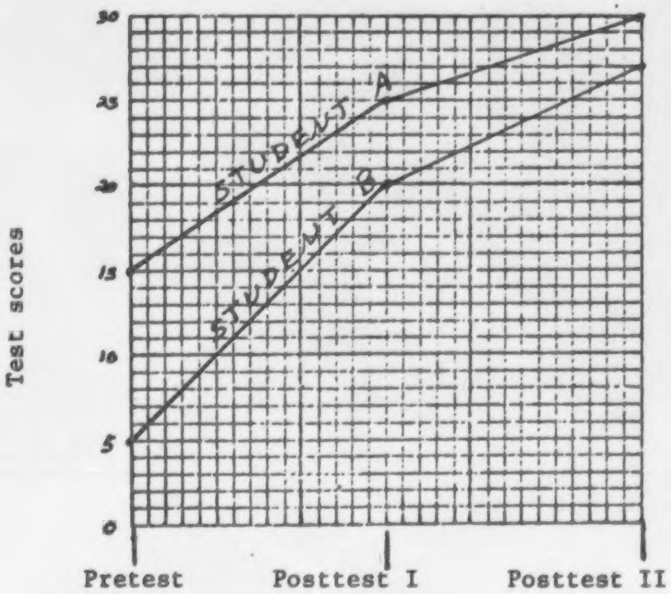
11. Which car seemed to have a reckless driver? ___________
Reason for answer:

12. Which car reached the greatest speed within the time shown on the graph? __________
Reason for answer:

13. Draw a curve on the graph showing an auto traveling 45 miles per hour and then gradually slowing down to 15 mph after a total time of 17 seconds. It continues to travel for 6 seconds at 15 mph and then gradually increases its speed to 30 mph after a total time of 28 seconds.

E. In an experiment on learning, two students were given a pretest on a set of Latin names for animals. After the pretest, the students were given time to study the Latin names and their English equivalents. This study period was followed by another test (or posttest I). In similar fashion, after another period of study the students received posttest II. The test scores for student A and student B are shown on the graph below.

Experiment on learning



14. Which of the following statements concerning student A and student B is true? Circle the letter of your choice.

A. Student B has learned more than student A. (total)

B. Student B has learned the same amount as student A. (total)

C. Student A has learned more than student B. (total)

D. Student A knew less than student B after the pretest. (total)

E. None of the above choices

Evaluation Sample (Cont.)
Grade 8
Earth Science
Unit: Using Data

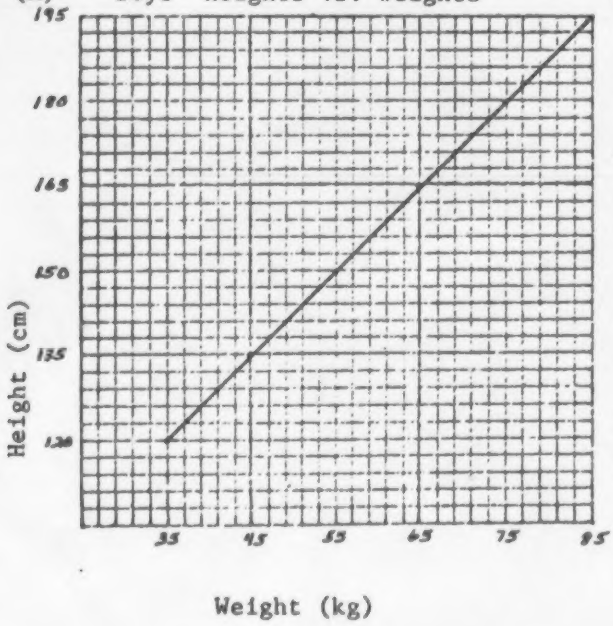
F. Below is a table that gives the heights and weights of several boys.

Boy	Height (cm)	Weight (kg)
1	120	35
2	135	40
3	150	45
4	165	60
5	180	80
6	195	85

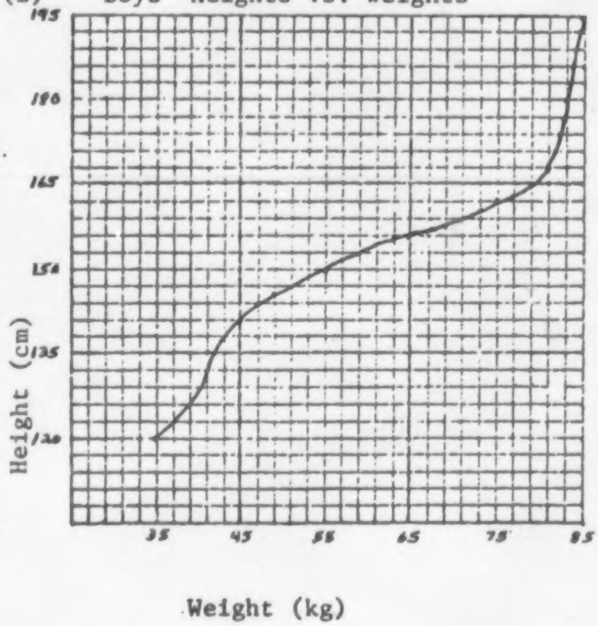
15. What is the range in height for the boys? ____________
What is the mean height for the boys? ____________

16. Which of the following four graphs correctly expresses the data in the table? Circle the letter of your choice.

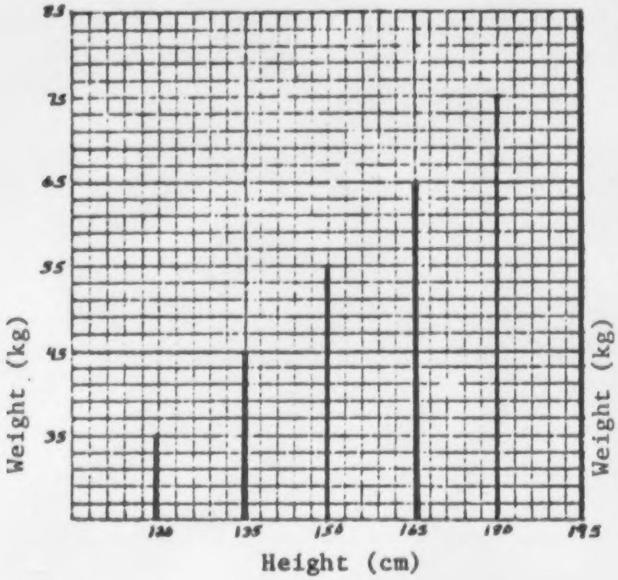
(A) Boys' heights vs. weights



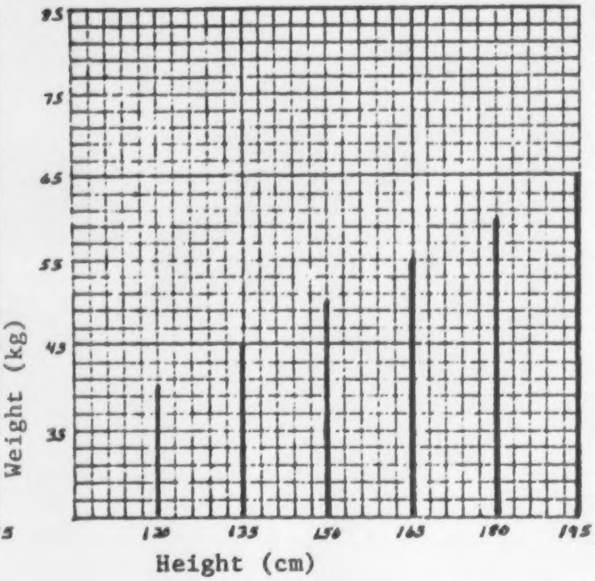
(B) Boys' heights vs. weights



(C)



(D)



17. On the basis of the data given, what pattern do you note?

G. Ten persons were selected to participate in an investigation into the differences that age makes in completing a mental task. One person at a time was brought into a room. The subject was given four cards and asked to unscramble the five letters appearing on one side. The unscrambled letters on each card were to form a common English word. Each person was allowed 60 seconds per word. The actual length of time (to the nearest 5 seconds) required to unscramble each set of words was recorded. All persons were given the same cards in the same order. When the session was completed, the person left by another door to prevent contact with those who were waiting.

On the following page is a record of the information taken by the person conducting the experiment.

Evaluation Sample (Cont.)
Grade 8
Earth Science
Unit: Using Data

Data Table: Results of Unscrambling Letters to Form Five-Letter Words

Subject number	Age	Time (in seconds) to unscramble			
		Card 1	Card 2	Card 3	Card 4
1	24	25	15	25	15
2	14	35	10	25	10
3	15	30	25	45	20
4	26	5	15	35	35
5	29	10	5	20	15
6	16	5	20	15	35
7	26	5	15	15	10
8	15	5	5	5	5
9	28	15	5	5	15
10	17	5	5	10	10

18. What was the range of times for all subjects to unscramble the four words? ________________

    What was the range of ages for the people involved in the experiment?

    ____

19. What was the mean time for each of the four cards?

    Card 1 _______ Card 2 _______ Card 3 _______ Card 4 _______

    What was the mean time for all four cards for people ranging from 14-16 years of age? _________________

20. Construct a graph of the results so that you can better interpret them.

21. Based on the preceding data the following conclusion was made:

If a person is older, then he will take longer to unscramble five-letter words.

Decide whether the conclusion should be accepted or rejected and state at least one reason why you made that decision.

Evaluation Sample (Cont.)
Grade 8
Earth Science
Unit: Using Data

Question	Objective(s)	Idea Source	Criteria for Scoring
1	1a	Lab-Inquiry Text: Earth Science	Range in time 0-6 min. Range in temp. 44-100°C
2	1a	Same as above	Mean temp. is 86.6°C
3	1b	Same as above	Data should fit graph. Graph should be labeled and points plotted accurately.
4	2b	Same as above	Should predict 100°C
5	1b	Test on Graphing and Graph Interpretation Skill	Same criteria as for number 3 above
6	2a	Same as number 5	Any generalization that is supported by the data should be accepted.
7	2b	Same as number 5	Height should be 5.8 cm.
8	2a, 2b	Same as number 1	Car D, 50 mph
9	2a, 2b	Same as number 1	Car C, 10-11 min.
10	2a	Same as number 1	Car A
11	2a	Same as number 1	Car B
12	2a	Same as number 1	Car B
13	1b	Same as number 1	The curve drawn by the student should fit the data.
14	2c	Same as number 5	Choice A
15	1a	Processes of Science Test	Range is 120-195 cm. Mean is 157.5
16	1b	Same as number 15	Choice C
17	1c	Same as number 15	A suitable response might be that there is an increase of 10 kg weight for each 15 cm height.

Evaluation Sample (Cont.)
Grade 8
Earth Science
Unit: Using Data

Question	Objective(s)	Idea Source	Criteria for Scoring
18	1a	Unified Science -- *Making Sense Out of Data*	Range of 5 seconds to beyond 60 seconds Range of 14-29 years
19	1a	Same as number 18	Card #1, 22 seconds Card #2, 21 seconds Card #3, 20 seconds Card #4, 24.5 seconds Mean time for 14-16 years is 57.5 seconds
20	1b	Same as number 18	Data should fit the graph and points be plotted accurately.
21	2c	Same as number 18	

Unit Outline
Grade 8
Earth Science
Unit: Astronomy

I. The Earth and Its Satellite

  A. Gravity and inertia
  B. The moon and its phases
  C. Night and day
  D. Reasons for seasons

II. Solar System

  A. Comparisons with the earth
    1. Gravitational field
    2. Rotation period
    3. Revolution period
  B. Major characteristics
  C. Exploration by man
    1. Lunar landings
    2. Unmanned fly-bys

III. Stars and Star Groups

  A. Representative star -- our sun
  B. Magnitudes and distances
  C. Major constellations
  D. Galaxies
    1. Irregular
    2. Elliptical
    3. Spiral
  E. Life of a star

IV. Extraterrestrial Life

  A. Life-supporting factors
  B. UFOs

Suggested Activities
Grade 8
Earth Science
Unit: Astronomy

OBJECTIVE: To illustrate how energy radiated from objects in space can be used to increase knowledge of the composition of the objects

TITLE: "Investigation of Spectra"

SOURCE: Teacher developed

OBJECTIVE: To construct a simple device for illustrating the obvious constellations and the brighter stars

TITLE: "Tin Can Planetarium"

SOURCE: Modified from an article by Fletcher G. Watson, November 1950

OBJECTIVE: To observe and measure the apparent motion of the heavenly bodies

TITLE: "The Astrolabe"

SOURCE: Eiss, Albert F., et al. Laboratory Manual for the Earth-Space Sciences. Laidlaw Brothers, Publishers.

OBJECTIVE: To apply one photographic technique to illustrate the apparent motion of heavenly bodies

TITLE: "The Apparent Motion of Stars"

SOURCE: Eiss, Albert F., et al. Laboratory Manual for the Earth-Space Sciences. Laidlaw Brothers, Publishers.

OBJECTIVE: To observe the motions and phases of the moon in a systematic fashion

TITLE: "Moon Watch"

SOURCE: Teacher modified from Harris, Hesser, Hynek, et al. Investigating the Earth. Houghton Mifflin Co., 1973.

OBJECTIVE: To use the geometry of similar triangles to determine the diameter of the moon

TITLE: "Determination of the Diameter of the Moon"

SOURCE: Teacher developed, source unknown

OBJECTIVE: To apply the relationship of the constellations to the North Star in determining time

TITLE: "Night Clock"

SOURCE: Jobb, Jamie. The Night Sky Book. Little, Brown and Co., 1977, p. 65.

Resources
Grade 8
Earth Science
Unit: Astronomy

Text Materials

Abraham, Norman; Chaney, Donald; Moores, Michael; Swift, Robert; and Notkin, Jerome J. Interaction of Earth and Time. Rand McNally and Company, 1972.

Allison, Linda. The Reasons for Seasons. Little, Brown and Co., 1975.

Eiss, Albert F., et al. Laboratory Manual for the Earth-Space Sciences. Laidlaw Brothers.

Harris, Miles F.; Hesser, Dale T.; Hynek, J. Allen; et al. Investigating the Earth. Houghton Mifflin Co., 1973.

Jackson, Joseph H., and Evans, Edward D. Spaceship Earth. Houghton Mifflin Co., 1973.

Jobb, Jamie. The Night Sky Book. Little, Brown and Co., 1977.

Ramsey, William L.; Burckley, Raymond A.; Phillips, Clifford R.; and Watenpaugh, Frank M. Modern Earth Science. Holt, Rinehart, and Winston, Inc., 1973.

Films

The Earth in Motion -- Indiana University

Eclipses of the Sun and Moon -- Indiana University

Exploring the Night Sky -- Indiana University

Life on Other Planets -- Columbus Public Library

Space Probes -- Columbus Public Library

Space Science: Exploring the Moon -- Grandview Heights Public Library

Space Science: The Sun as a Star -- Indiana University

Stars Through the Seasons -- Indiana University

Unseen World III: Oceans of Space -- Grandview Heights Public Library

What Is Space? -- Indiana University

Filmstrips -- Hastings Junior High

- Changing Seasons
- Constellations
- Looking at the Stars

Film Loops -- Hastings Junior High

- Earth Rotation and Revolution

Transparencies -- Hastings Junior High

- Astronomy: Outer Space
- The Earth
- Satellites, Natural and Artificial
- Space Travel
- Star and Constellation Recognition
- The Sun's Family
- The Universe

Exemplary Activity
Grade 8
Earth Science
Unit: Astronomy

OBJECTIVE: To observe the motions and phases of the moon in a systematic fashion

MATERIALS AND EQUIPMENT: Paper and pencil, binoculars or telescope (optional)

PROCEDURE:

Each student will make observations of the moon over a two-month period of time and record those observations.

1. Include the following information on your data sheet:
   a. Date of observation
   b. Time of each observation
   c. The direction of the moon (N, NE, E, etc.)
   d. The height of the moon in degrees (the horizon is 0° and directly overhead would be 90°)
   e. The moon's phase (may be drawn)
   f. Positions of any nearby stars
2. The observations should be made several times each day on a regular schedule; for example, on the way to and from school, after dinner, just before bed.
3. From the observations and data, make some general conclusions about the moon's appearance and movement.

Evaluation Sample
Grade 8
Earth Science
Unit: Astronomy

Multiple Choice. Choose the correct answer and fill in the correct letter in the blank (2 points each).

____ 1. The newly discovered spiral galaxy only 55,000 light years away is (A) Hershey (B) Milky Way (C) Mars (D) Snickers.

____ 2. A vast cloud of dust and gas in space is a (A) nebula (B) nova (C) star (D) solar system.

____ 3. Milky Way is the name of our (A) solar system (B) moon (C) nebula (D) galaxy.

____ 4. An exploding star is a (A) nebula (B) pulsar (C) red giant (D) nova.

____ 5. The raw material for fusion is (A) carbon dioxide (B) hydrogen (C) helium (D) oxygen.

____ 6. A spectrograph is used to determine (A) brightness of a star (B) temperature of a star (C) mass of a star (D) volume of a star.

____ 7. The coldest stars are (A) red (B) yellow (C) blue (D) green.

____ 8. The most common galaxy shape is (A) elliptical (B) spiral (C) lenticular (D) irregular.

____ 9. A star begins its life when dusts and gases in a nebula are attracted by (A) gravitation (B) magnetism (C) skepticism.

____10. A white dwarf has (A) high density, low temperature, high luminosity
(B) high density, high temperature, low luminosity
(C) low density, high temperature, low luminosity
(D) low density, low temperature, low luminosity.

____11. Stellar means (A) nova (B) nebula (C) red giant (D) star.

____12. All energy produced by a star is called (A) visible light (B) electromagnetic energy (C) radio waves (D) heat.

____13. The person who is given credit for classifying galaxies is (A) Hertzsprung (B) Russell (C) Hubble (D) Galileo.

____14. The North Star is (A) Antares (B) Andromeda (C) Polaris (D) Vega.

____15. An instrument used to determine the luminosity of stars is a (A) photometer (B) telescope (C) quasar (D) spectroscope.

Evaluation Sample (Cont.)
Grade 8
Earth Science
Unit: Astronomy

____16. The luminosity of the sun is (A) .001 (B) .01 (C) 1.0 (D) 10.0.

____17. On the H-R diagram, our sun is (A) yellow (B) white (C) red (D) blue.

____18. On the H-R diagram, the temperature __?__ from left to right. (A) increases (B) decreases (C) remains the same

____19. The brightest star in the northern hemisphere is (A) Polaris (B) Sirius (C) Capella (D) Vega.

____20. The Big Bang Theory states that (A) one body of matter exploded about 10 billion years ago (B) new matter is constantly being created everywhere (C) expanding and contracting is repeated every 80 years (D) the universe will end with a tremendous explosion.

____21. The moebius band was used in our class to describe the (A) shape of the Milky Way (B) shape of a nebula (C) shape of the universe (D) shape of a pulsar.

____22. Scientists know that this was formed after a supernova exploded: (A) universe (B) Great Nebula Orion (C) Crab Nebula (D) Snicker's Galaxy.

____23. The Doppler effect shows that (A) stars are getting colder (B) stars are getting hotter (C) stars are getting brighter (D) stars are moving away from us.

____24. The H-R diagram was designed by (A) Russell and Hubble (B) Hertzsprung and Roberts (C) Roberts and Hubble (D) Russell and Hertzsprung.

____25. A large group of stars arranged in some pattern is a (A) galaxy (B) nova (C) nebula (D) pulsar.

____26. Density equals (A) volume divided by mass (B) volume subtracted from mass (C) mass divided by area (D) mass divided by volume.

____27. Masses of gases undergoing fusion are (A) nebulas (B) stars (C) photospheres (D) hubbles.

____28. The effect of gravity on a star is that it makes (A) the star contract (B) the star expand (C) the volume increase (D) the density decrease.

Evaluation Sample (Cont.)
Grade 8
Earth Science
Unit: Astronomy

____29. After the white dwarf stage, a star probably (A) explodes (B) becomes stable (C) cools and becomes dark (D) becomes a giant.

____30. In the experiment dealing with the density of water, if there had been no experimental errors, we would expect 15 milliliters of water to weigh (A) 1 gram (B) 1 pound (C) 1.5 grams (D) 15 grams.

____31. The density of water is (A) .5 gm/ml (B) 1 gm/ml (C) 1 ml/gm (D) 10 gm/ml.

____32. Most stars on the H-R diagram are __?__ stars. (A) giant (B) main sequence (C) white dwarf (D) supergiant

____33. Stars that undergo so much gravitation that even light cannot escape are (A) white dwarfs (B) pulsars (C) quasars (D) black holes.

____34. These resemble stars but produce as much energy in one second as a regular star does in its whole lifetime: (A) pulsars (B) novas (C) quasars (D) planets.

____35. These scientists study stars, galaxies, and meteors: (A) meteorologists (B) geologists (C) astronomers (D) oceanographers.

List these in order from smallest to largest. (Be sure and spell them correctly; 1 point each.)

36. ______________________ (smallest)

37. ______________________

38. ______________________

39. ______________________

40. ______________________

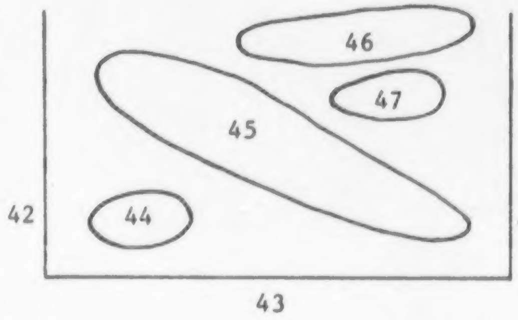
41. ______________________ (largest)

planet
universe
moon
solar system
sun
galaxy

Evaluation Sample (Cont.)
Grade 8
Earth Science
Unit: Astronomy

Matching. Use this H-R diagram and label the following (2 points each).

____42.
____43.
____44.
____45.
____46.
____47.



(A) temperature
(B) white dwarf
(C) luminosity
(D) giant
(E) super giant
(F) main sequence

Essay. Choose 1 of the following (worth 6 points).

1. Describe 3 scientific theories for the creation of the universe.

2. Describe the life history of a star and the source of its energy.

Essay. Choose 1 of the following (worth 6 points).

1. Describe differences in reflector, refractor, and radio telescopes.

2. Describe the classification of galaxy shapes.

Unit Outline
Grade 8
Earth Science
Unit: Geology

I. Topographic Maps

- A. Determining locations and directions
  - 1. Longitude and latitude
  - 2. Magnetic and geographic north
  - 3. Township coordinates
- B. The information placed on a topographic map
  - 1. Scales
    - a. Fractional
    - b. Linear
    - c. Verbal
  - 2. Datum plane
  - 3. Magnetic declination
  - 4. Colors
    - a. Brown
    - b. Green
    - c. Red
    - d. Black
    - e. White
    - f. Blue
  - 5. Symbols
    - a. Buildings
    - b. Railroads
    - c. Major highways
    - d. Secondary roads
    - e. Cemetery
    - f. Major streams, rivers
    - g. Tributary stream
    - h. Intermittent stream
    - i. Pond
  - 6. Contour lines
    - a. Definition
    - b. Description
    - c. Contour interval
    - d. Gradient
    - e. Crossing streams
    - f. Elevation
    - g. Determine up and down
    - h. Depression
    - i. Determine top and bottom

II. Glacial Study

- A. Pleistocene Epoch
- B. Valley glaciers and continental glaciers
- C. Types of ice masses
- D. The formation of glacial ice

- E. Glacial weathering
- F. Glacial erosion
- G. Glacial deposits

III. Plate Tectonics

- A. Theories
  - 1. Continental drift
  - 2. Plate tectonics
- B. Matching continents
  - 1. Continents fit together like a puzzle
  - 2. All land might once have been one continent
- C. Paleomagnetism
  - 1. Shape of the sea floor
  - 2. Changing magnetic polarity of the earth
- D. Sea floor spreading
  - 1. Magnetic reversals
  - 2. Shape of the sea floor
  - 3. Age of sea floor crust
- E. Volcanic activity
  - 1. Volcanic action and newly formed crust
  - 2. Processes going on beneath crust that may cause volcanic action
- F. Convection cells
  - 1. Sea floor spreading and continental drift
  - 2. Plate movement
  - 3. Sea floor features
  - 4. Surface evidence in Iceland
- G. Earthquakes
  - 1. Earthquakes and plate boundaries
  - 2. Significance of depth of earthquakes
  - 3. Sea floor and land features

IV. Related Chemistry

- A. The earth's physical environments
  - 1. Atmosphere
  - 2. Hydrosphere
  - 3. Lithosphere
- B. The elements
- C. Periodic Table of the Elements
- D. Compounds and mixtures

V. Mineralogy

- A. Minerals as chemicals
- B. Formation of minerals
- C. Uses of minerals
- D. Characteristics and properties of minerals
- E. Identification of minerals

VI. Petrology

- A. Rocks as chemicals and minerals
- B. Description and classification of rocks
    - 1. Origin
        - a. Igneous
        - b. Metamorphic
        - c. Sedimentary
    - 2. Mineral composition
    - 3. Texture
    - 4. Color
- C. Rock cycle
- D. Identification of rocks

VII. Weathering and Erosion

- A. Mechanical
    - 1. Examples
    - 2. Agents
- B. Chemical
    - 1. Examples
    - 2. Agents
- C. Results of weathering and erosion
- D. Rate of weathering
- E. Soil formation

Suggested Activities
Grade 8
Earth Science
Unit: Geology

OBJECTIVE: To make students aware of the variety of maps used in the earth sciences

TITLE: "Examples of Maps"

SOURCE: Teacher developed. Use a variety of maps including topographic, hydrologic, geographic, geologic, forest, highway, raised relief, vegetation, political, oil, and gas.

OBJECTIVE: To determine the latitude and longitude locations to the nearest 15 seconds on 7.5 minute series topographic maps

TITLE: "Determining Latitude and Longitude"

SOURCE: Teacher developed. Use Perry Quadrangle Topographic Map 7.5 Minute Series, Pond Run Quadrangle Topographic Map 7.5 Minute Series, New Richmond Quadrangle Topographic Map 7.5 Minute Series.

OBJECTIVE: To have students draw contour lines on an acetate sheet placed atop a three-dimensional model that is being covered with water

TITLE: "Determining Contour Lines"

SOURCE: Teacher developed. Use a three-dimensional model of Capulin Peak in a water-tight box.

OBJECTIVE: To have students read information from topographic maps, such as map series, scales, contour interval, latitude, longitude, highways, streams, rivers, elevations, interpretation of contour lines, distances, manmade features, natural features

TITLE: "Topographic Map Features"

SOURCE: Teacher developed. Use Pond Run Quadrangle, Lebanon Quadrangle, Pemberville Quadrangle, Oakwood Quadrangle 7.5 Minute Series Topographic Maps.

OBJECTIVE: To make a profile drawing of two different glacial deposits

TITLE: "A Puzzle of Glacial Deposits"

SOURCE: Teacher developed. Use data sheet, graph paper, and answer sheet.

OBJECTIVE: To observe and identify glacial features in the Rocky Mountain National Park

TITLE: "Rocky Mountain National Park Glaciation"

SOURCE: Topographic Maps for Earth Science by Brown. Use raised relief map of Rocky Mountain National Park.

OBJECTIVE: To observe ice fields, Alpine glaciers, and fiords

TITLE: "Ice Fields and Alpine Glaciers"

SOURCE: Topographic Maps for Earth Science by Brown

OBJECTIVE: To study glacial weathering and erosion features of Rocky Mountain National Park

TITLE: "Alpine Glaciation"

SOURCE: Topographic Maps for Earth Science by Brown

OBJECTIVE: To compare a glaciated area to an unglaciated area by slope, differences in elevation between high points and low points, the shapes of streams and rivers, depths of the river valleys, and the contour intervals

TITLE: "Comparing a Glaciated Area to an Unglaciated Area in Ohio"

SOURCE: Teacher developed. Use Berghols Quadrangle Topographic Map and Oakwood Quadrangle Topographic Map.

OBJECTIVE: To study glacial deposits of Ohio and to compare the glaciated area to the unglaciated area

TITLE: "Ohio Glacial Geology"

SOURCE: Teacher developed. Use Glacial Map of Ohio, Physiographic Map of Ohio, and Geologic Map of Ohio.

OBJECTIVE: To show that the continents of the earth fit together as if they may have been a single continent at one time

TITLE: "Continental Jigsaw Puzzle"

SOURCE: Ohio State University Crustal Evolution Project. Use shapes of the continents drawn on 8 1/2 x 11 paper.

OBJECTIVE: To show students the paleomagnetic symmetry of the seafloor and its relationship to the shape of the seafloor

TITLE: "Seafloor Spreading"

SOURCE: Ohio State University Crustal Evolution Project. Use model of the seafloor.

OBJECTIVE: To illustrate the cause and appearance of a convection cell

TITLE: "Convection Cells"

SOURCE: Ohio State University Crustal Evolution Project. Use potassium dichromate, water, and heat.

OBJECTIVE: To show the association of earthquake zones to plate boundaries

TITLE: "Earthquakes"

SOURCE: Ohio State University Crustal Evolution Project. Use world map with data representing the earthquakes that occurred during one year.

OBJECTIVE: To have students use chemicals to see the results of a chemical reaction

TITLE: "Acid-Base Reaction"

SOURCE: Teacher developed. Use hydrochloric acid, sodium hydroxide, ring stand, wire gauze, alcohol burner, matches, and beaker.

OBJECTIVE: To determine information about symbols, atomic number, atomic weight, protons, neutrons, electrons, valence, periods, groups, isotopes, gas, liquid, solid, metal, nonmetal, and metalloid

TITLE: "Periodic Table Worksheets"

SOURCE: Teacher developed. Use Periodic Table of the Elements (8 1/2 x 11 size).

OBJECTIVE: To become familiar with the characteristics of luster, cleavage, fracture, crystal form, streak, hardness, and color

TITLE: "Determining Mineral Characteristics"

SOURCE: Teacher developed. Use ten minerals, penny, glass jar, and streak plate.

OBJECTIVE: To help students become familiar with the identification key before working with mineral samples

TITLE: "Identifying Minerals Using a Mineral Key"

SOURCE: Teacher developed. Use Key for the Identification of Minerals, written descriptions of six minerals.

OBJECTIVE: To have students identify at least ten minerals by identifying a mineral's characteristics and then using a mineral key to identify them

TITLE: "Identifying Minerals Using a Mineral Key"

SOURCE: Teacher developed

OBJECTIVE: To become aware of the great variety of rocks

TITLE: "Rock Scramble"

SOURCE: Teacher developed. Use 25 samples of different rocks.

OBJECTIVE: To identify samples of igneous, metamorphic, and sedimentary rocks

TITLE: "Identification of Rocks"

SOURCE: Teacher developed. Use samples of igneous, metamorphic, and sedimentary rocks; rock descriptions; worksheet.

OBJECTIVE: To improve inferring capabilities in the determination of erosion types from representative photographs

TITLE: "Defining a Problem"

SOURCE: Abraham, Chaney, Moores, Swift, and Notkin. Interaction of Earth and Time. Rand McNally and Co., 1972, p. 273.

OBJECTIVE: To demonstrate the influence of the land surface type on the rate of water absorption by the ground

TITLE: "Infiltration"

SOURCE: Teacher developed from Ohio State University workshop

Resources
Grade 8
Earth Science
Unit: Geology

Text Materials

Brown, Martin F., and Thompson, Ray W. Topographic Maps for Earth Science. Silver Burdett Co., 1970.

Jackson, Joseph H., and Evans, Edward D. Spaceship Earth. Houghton Mifflin Co., 1973.

Ramsey, William L.; Burckley, Raymond A.; Phillips, Clifford R.; and Watenpaugh, Frank M. Modern Earth Science. Holt, Rinehart, and Winston, Inc., 1973.

Films

Continental Glaciers -- Ohio State University

Continents Adrift -- Ohio State University

Face of the Earth -- Grandview Heights Public Library

Mountain Glaciers -- Ohio State University

Rocks That Form on the Earth's Surface -- Indiana University

Rocks That Originate Underground -- Indiana University

Secrets of the Ice -- Indiana University

Filmstrips

Geomorphology Series -- Jones Library

Igneous Rocks -- Jones Library

Maps, National Geographic -- Jones Library

Metamorphic Rocks -- Jones Library

Rocks -- Jones Library

Sedimentary Rocks -- Jones Library

Slides

Crustal Evolution Project Series -- Ohio State University

Exemplary Activity
Grade 8
Earth Science
Unit: Geology

OBJECTIVE: To demonstrate the influence of the land surface type on the rate of water absorption by the ground

MATERIALS AND EQUIPMENT: Metric ruler, #10 can (open at both ends), 2-pound coffee can, water, wrist watch with second hand, notebook with pen or pencil, putty knife or kitchen knife

BACKGROUND:

Type of soil has a lot to do with rate of erosion. In the area of the Jones athletic field, there are several types of ground cover. In this lab, five areas will be studied to compare rates of infiltration. Infiltration is the absorption of water into the ground.

When the lab is finished and the results of all test sites are reviewed, you will have a better understanding of the influence the type of land surface has on how fast water will be absorbed by the ground.

PREPARATION:

1. Have a measured amount of water in the smaller can (2-pound).
2. Be ready to measure the infiltration time.
3. Be ready to record depth of water in the larger can after water has drained.
4. Be prepared with pen and notebook to record the time and depth.

PROCEDURE:

1. Work in a group of no more than five people.
2. Take materials and equipment to your assigned testing site.
3. Set the large can in the ground so the bottom is about an inch deep in the ground.
4. When timer gives the signal, pour the water into the can that is set in the ground. Pour fast, but not so fast that it splashes out.
5. Record the number of minutes and seconds it takes for the water to infiltrate.
6. Measure the number of centimeters depth the water was in the large can.
7. Measure the depths at one minute intervals for at least five minutes, if possible.
8. Answer the questions.

Exemplary Activity (Cont.)
Grade 8
Earth Science
Unit: Geology

______________________ 8-___ Group number ____ Science period ____ Date __________
name
______________________ 8-___ Group number ____
name
______________________ 8-___ Group number ____
name
______________________ 8-___ Group number ____
name
______________________ 8-___ Group number ____
name

RESULTS:

1. Depth of water in centimeters _____ cm

2. Number of minutes taken for infiltration _____ minutes

3. Rate of infiltration (cm/min) _____ cm/min

4. Type of ground surface (grass, gravel, cinders, clay, sand, hard, soft, dry, wet) __________

QUESTIONS:

1. What problems did you encounter while doing the test?

2. How accurate do you think your results were? (Give the reason for your answer.)

3. What could be done to improve the accuracy of your test?

4. How did the rate of infiltration of your test compare with the other groups?

5. Considering all the tests made by the class, what effect does the type of ground surface seem to have upon the rate of infiltration?

Evaluation Sample
Grade 8
Earth Science
Unit: Geology

PART I. Multiple Choice, 20 points. Place the letter representing the correct answer on the space at the left of the question.

____ 1. The irregular surface formed when a mineral breaks is (A) cleavage (B) crystal form (C) fracture (D) luster.

____ 2. Naturally formed compounds in the earth's solid structure are (A) atoms (B) electrons (C) minerals (D) isotopes.

____ 3. The hardest and most abundant of the common minerals is (A) augite (B) hornblend (C) quartz (D) sulfur.

____ 4. The natural substance formed when minerals are mixed together is a (an) (A) element (B) molecule (C) rock (D) silicate.

____ 5. Compounds formed by a chemical combination of carbon and oxygen are (A) carbonates (B) minerals (C) phosphates (D) silicates.

____ 6. The most abundant mineral group is the (A) carbonate group (B) phosphate group (C) silicate group (D) sulfate group.

____ 7. The formula for a valuable iron oxide is (A) Fe_2O_3 (B) PbS (C) SiO_2 (D) ZnS.

____ 8. Whether a mineral is metallic or nonmetallic is its classification by (A) cleavage (B) luster (C) streak (D) weight.

____ 9. The softest of these objects is (A) fingernail (B) glass (C) nail (D) penny.

____10. The mark a mineral makes on a piece of unglazed porcelain is its (A) color (B) hue (C) mark (D) streak.

____11. Breaking along flat surfaces is (A) brittleness (B) cleavage (C) hardness (D) luster.

____12. A physical characteristic that is the least reliable to identify a mineral is (A) cleavage (B) color (C) hardness (D) streak.

____13. Rocks that form from magma are classified as (A) igneous (B) metallic (C) metamorphic (D) sedimentary.

____14. Minerals that are good enough quality to use as jewelry are called (A) atoms (B) carbonates (C) crystals (D) gems.

____15. The silicate mineral formula listed here is (A) $CaCO_3$ (B) $CaPO_4$ (C) Fe_2O_3 (D) $KAlSi_3O_8$.

____16. The most abundant element in the earth's solid crust is (A) aluminum (B) iron (C) oxygen (D) silicon.

____17. The smallest part of a compound is a (an) (A) atom (B) element (C) mineral (D) molecule.

____18. The mineral that provides us with lead is (A) calcite (B) fluorite (C) galena (D) quartz.

____19. The mineral that attracts a magnet is (A) gypsum (B) magnetite (C) pyrite (D) sphalerite.

____20. The mineral composed entirely of silicon and oxygen (SiO_2) is (A) biotite (B) fluorite (C) gypsum (D) quartz.

PART II. Mineral Identification, 10 points

DIRECTIONS:

1. Fill in the information asked for in each space.
2. Look at the number with the mineral and put the information in the spaces on the answer sheet.
3. Write the number found with the mineral on the space at the left.
4. The mineral is new (not used in the lab).
5. The mineral is not magnetic.
6. The mineral will not bubble in hydrochloric acid.

MATERIALS:

1. Key for the Identification of Minerals
2. One mineral in a plastic bag
3. Streak plate
4. Glass jar
5. Penny (provided by student)

MINERAL NUMBER	METALLIC OR NONMETALLIC	HARDNESS (MOH'S NUMBER)	COLOR OF STREAK	FRACTURE, CLEAVAGE, OR CRYSTAL FORM	MINERAL NAME

Unit Outline
Grade 8
Earth Science
Unit: Meteorology

I. The Atmosphere
  A. Its origin
  B. Its composition
  C. Pollution

II. The Heating of Air
  A. Absorption and reflection of solar energy
  B. Heat transfer
    1. Radiation
    2. Convection
    3. Conduction

III. Air Pressure
  A. Explanation of
  B. Measurement of -- the barometer
    1. Types
    2. Reading
  C. Winds
    1. Planetary
    2. Local

IV. Moisture in the Air
  A. The water cycle
  B. Humidity
    1. Measurement
    2. Frost and dew
  C. Cloud formation and types
  D. Precipitation

V. The Changing Atmosphere
  A. Air masses
  B. Weather fronts
  C. The weather map
  D, Violent storms

Suggested Activities
Grade 8
Earth Science
Unit: Meteorology

OBJECTIVE: To see whether land and water differ in the absorption and radiation of heat energy

TITLE: "Heating Land and Water"

SOURCE: Interaction of Earth and Time. Investigation 7.4, p. 151.

OBJECTIVE: To study the development of a temperature inversion

TITLE: "The Meaning and Development of a Temperature Inversion"

SOURCE: Namowitz. Activities in Earth Science. American Book Co., 1975, Exercise 38, p. 127.

OBJECTIVE: To show that warm air rises and is replaced with cooler air

TITLE: "An Effect of Heating"

SOURCE: Interaction of Earth and Time. Investigation 7.3, p. 149.

OBJECTIVE: To develop a model to explain why it is warmer at the equator than at the poles and thus explain the driving force behind the winds

TITLE: "Differential Heating of the Earth"

SOURCE: Interaction of Earth and Time. Investigation 7.11, p. 174.

OBJECTIVE: To find the dew point in the classroom and outside and compare

TITLE: "Finding the Dew Point"

SOURCE: Interaction of Earth and Time. Investigation 7.7, p. 159.

OBJECTIVE: To practice the skill of reading and analyzing graphs

TITLE: "Analyzing Records"

SOURCE: *Interaction of Earth and Time*. Investigation 7.16, p. 171.

OBJECTIVE: To observe the development of a frontal system

TITLE: "Following the Development of a Frontal System"

SOURCE: Eisler, Stack, Disantis. *Lab-Inquiry Text -- Earth Science*. Cambridge, 1973, problem 6-7, p. 183.

OBJECTIVE: To practice reading the weather information shown in the station model of the United States Weather Bureau daily weather map

TITLE: "Reading the Station Model on a Weather Map"

SOURCE: Namowitz. *Activities in Earth Science*. Ex. 44, p. 151.

OBJECTIVE: To study the changes in weather that take place during the passage of a hurricane

TITLE: "Hurricane Weather"

SOURCE: Namowitz. *Activities in Earth Science*. Ex. 43, p. 147.

OBJECTIVE: To become familiar with some weather forecasting instruments and to use those instruments in the collection and interpretation of data

TITLE: "Weather Watch Laboratory"

SOURCE: Developed by Phil Hord

Suggested Activities (Cont.)
Grade 8
Earth Science
Unit: Meteorology

OBJECTIVE: To enumerate the interrelationships of the factors involved in cloud formation

TITLE: "Programmed Learning Unit -- The Formation of a Cloud"

SOURCE: Developed by Phil Hord

Resources
Grade 8
Earth Science
Unit: Meteorology

Text Materials

Interaction of Earth and Time. Interaction Science Curriculum Project. Rand McNally, 1972, pp. 140-187.

Ramsey, Burckley, Phillips, Watenpaugh. Modern Earth Science. Holt, Rinehart, Winston, 1973, pp. 420-478.

Films

Storms: The Restless Atmosphere, 22 min., EBEC, Westerville Library

Unchained Goddess, 57 min., Bell, Franklin County Library

What Makes Clouds?, 19 min., EBEC, Columbus Public Library

What Makes the Wind Blow?, 16 min., color, EBF, Columbus Public Library

Your Chance to Live: Tornado, 12 min., Westerville Library

Transparencies

Weather, Hastings Library

Exemplary Activity
Grade 8
Earth Science
Unit: Meteorology

OBJECTIVE: To become familiar with some weather forecasting instruments and to use those instruments in the collection and interpretation of data

MATERIALS AND EQUIPMENT: See Procedure

PROCEDURE:

Students will collect data on an assigned basis during the first five minutes of each class day. A group of three students will read the instruments and collect the data. The instruments and general observations will be divided into three groups so that each student in a pre-assigned group will be responsible for a specified set of readings and observations.

Grouping of Weather Instruments

I	II	III
Anemometer	Barometer	Psychrometer
Rain gauge	Thermometer	Wind vane
Weather report (newspaper)		Cloud type
		Weather conditions

Each group of three students, as mentioned above, will be responsible for the readings for a three day period of time. One student in the group should take group I instruments, another student should take group II instruments, and the third student should take group III instruments. EACH STUDENT SHOULD READ A DIFFERENT SET OF INSTRUMENTS EACH DAY.

Should a student be ill on the assigned day of readings, the remaining two students in the group will be responsible for that data.

After collecting the data, the students will copy it on the chalkboard for that day. At this time, all students will place the data on their own individual data sheets.

Instrument and Observation Description

Anemometer

This instrument is used to determine the wind speed. The "cup" portion of the instrument is mounted on a roof. When the wind hits the cups, it causes them to rotate; the faster the wind, the faster the cups rotate. A small electrical current is sent along a wire to a box mounted indoors. The current causes the needle to deflect and the wind speed can be read directly from the scale in miles per hour.

Recording Thermometer

This type of thermometer keeps a minute by minute record of the temperature. The temperature-sensing portion of the instrument is mounted outdoors and transmits by means of a liquid-filled tube to the rest of the instrument, which is kept indoors. An arm with a pen on the end marks the temperature on the graph, which is mounted on a revolving drum. Thus a permanent record can be kept for any time of the day, any time of the year.

You are to record the temperature at the time you are doing the readings. PERSONS DOING THE TEMPERATURE FOR MONDAY SHOULD ALSO DETERMINE THE TEMPERATURE FOR SATURDAY AND SUNDAY, AT THE TIME THEY NORMALLY HAVE SCIENCE CLASS DURING THE WEEK.

Recording Barometer

This is an instrument that is used to keep a minute by minute record of the air pressure. The arm with a pen attached to the end marks on the graph, which is attached to a revolving drum. There is an airtight metal box from which most of the air has been removed. As the air pressure increases, the sides of the box move in slightly. If the air pressure decreases, the sides are free to move out again. The movements of the box are transmitted to the arm and magnified.

You are to record the pressure at the time you make your readings. PERSONS DOING THE AIR PRESSURE ON MONDAY SHOULD ALSO DETERMINE WHAT IT WAS FOR SATURDAY AND SUNDAY, AT THAT TIME OF THE DAY THEY NORMALLY HAVE SCIENCE CLASS.

Rain Gauge

The rain gauge is used to determine the amount of precipitation that fell. Remove the top half of the pole and lower it so that you can take the reading; then replace it. The water will not be removed daily, so you must SUBTRACT THE PREVIOUS DAY'S READING.

Wind Vane

Wind direction is determined by this instrument. The arrow points in the direction from which the wind is coming.

Sling Psychrometer

This instrument is used to determine the "relative humidity." It will be kept by the teacher, along with a relative humidity table and bowl of room temperature water.

Sling Psychrometer (Cont.)

Before going outside, dip the sock in the water. While outside, sling the thermometer until the temperature of the wet-bulb thermometer lowers no further. Record the temperature of both the wet and dry bulb thermometers while outdoors.

Look on a data table for the relative humidity. (The teacher will explain how to use it before any readings are done.)

Weather Conditions

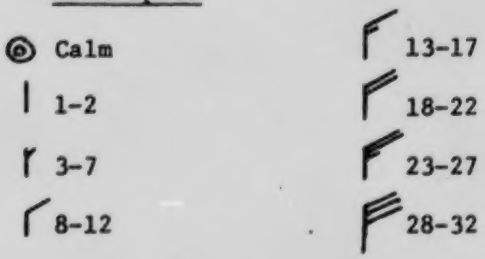
To perform this observation, you just have to indicate whether it is snowing, raining, cloudy, clear, etc. If it is cloudy, you should note the approximate percentage.

Cloud Type

If clouds are present, determine whether they are billowy or sheet-like.

Symbols to Be Used

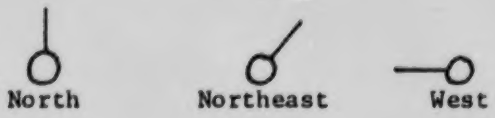
Wind Speed



Wind Direction

The location of the arrow indicates the direction from which the wind is coming. North is up.

Examples:



Exemplary Activity (Cont.)
Grade 8
Earth Science
Unit: Meteorology

Sky Condition

The amount of overcast is indicated by a circle and shading.

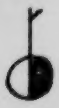
Examples:

○ Less than 2/10

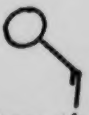
◑ 2/10 - 8/10

● More than 8/10

WIND SPEED, WIND DIRECTION, AND SKY CONDITION WILL BE COMBINED ON THE GRAPH. SEE EXAMPLES BELOW.



Wind from the North at 3-7 mph. Sky overcast (2/10-8/10)

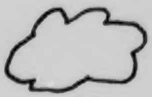


Wind from the SE at 13-17 mph. Sky clear.

Cloud Type

The clouds are indicated as being sheet-like or puffy.

sheet-like



puffy

Teacher developed by Phil Hord

Evaluation Sample
Grade 8
Earth Science
Unit: Meteorology

Earth Science Test
Storms and Clouds

PART ONE. MATCHING. PLEASE USE CAPITAL LETTERS.

____ 1. another name for a thunderhead

____ 2. a high altitude, wispy cloud

____ 3. a puffy, fair weather cloud

____ 4. a sheetlike cloud

____ 5. sometimes called "cloud dust"

____ 6. having to do with the sea

____ 7. a prefix that means middle altitude

____ 8. shock waves from rapidly expanding air cause this

____ 9. another name for moisture in the air

____10. a layer of warm air atop a layer of cold air

A. Alto-
B. Cirro-
C. Cirrus
D. Condensation nuclei
E. Cumulus
F. Cumulonimbus
G. Hail
H. Humidity
I. Marine
J. Strato-
K. Stratus
L. Seal
M. Thunder
N. Temperature inversion

PART TWO. FILL IN THE SPACE WITH THE WORD OR PHRASE THAT BEST COMPLETES THE SENTENCE.

11.____________________ The center of a tornado is (11) pressure.

12.____________________ The average hurricane lasts about (12).

13.____________________ A tornado forms from a (13) cloud.

14.____________________ Hurricanes form over (14) in areas near the (15).

15.____________________

16.____________________ The calm center of a hurricane is called the (16).

17.____________________ A tornado or thunderstorm forms when (17) moist air

18.____________________ from the south meets (18) dry air from the north.

19.____________________ Precipitation that falls when both the air and cloud temperatures are below freezing is called (19).

20.______________________ Give two of the three ingredients in the cloud

21.______________________ recipe (20, 21).

22.______________________ The (22) side of the mountain usually receives the most rain.

23.______________________ Cool air is needed for cloud formation. By what process does air cool itself?

24.______________________ During a hurricane, the barometric pressure (24).

25.______________________ The best place to be during a tornado if you are on the road is the (25).

PART THREE. TRUE AND FALSE. PLEASE WRITE THE WORD "TRUE" IF THE STATEMENT IS TRUE AND THE WORD "FALSE" IF THE STATEMENT IS FALSE.

26.______________________ The center of a hurricane is low pressure.

27.______________________ A hurricane could travel through Ohio.

28.______________________ The western states have more tornadoes than the midwest.

29.______________________ A city in a marine climate would have a large temperature range.

30.______________________ A temperature inversion can be responsible for air pollution.

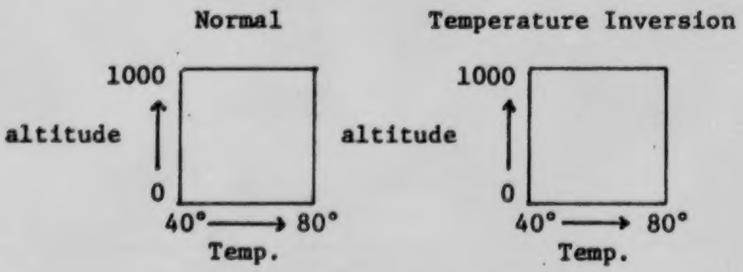
PART FOUR. SHORT ESSAY. PLEASE USE COMPLETE SENTENCES.

31-32. Explain how hail is formed.

33-34. Explain why there is desert on the eastern side of the Cascade Mountains.

35-36. What is lightning? How does it form?

37-38. In the blocks below, draw a line that would represent normal air and a temperature inversion.


Normal
Temperature Inversion
1000
altitude
0
40°
80°
Temp.
1000
altitude
0
40°
80°
Temp.

39-40. Why does very low barometric pressure cause high wind?

Unit Outline
Grade 8
Earth Science
Unit: Oceanography

I. History of Oceanography

  A. Mythology and religion
  B. Seamanship and inventions
  C. Aesthetics

II. Geological Oceanography

  A. Continental drift
  B. Origin of the Pacific Ocean
  C. Ancient ocean life
  D. The ocean basins and ocean bottom terrain
  E. Classification of depth zones
  F. Classification of shore terrain
  G. Ocean sediments, mineral exploration, and exploration controls
  H. Instruments used by the marine geologist

III. Physical Oceanography

  A. Ocean circulation
  B. Waves (deep, shallow) and the effects of waves on shores
  C. Instruments used by physical oceanographers

IV. Chemical Oceanography

  A. Water cycle
  B. Salinity and particulate matter
  C. Temperature variations
  D. Gases (oxygen, carbon dioxide, nitrogen) and pH
  E. Instruments used by the chemical oceanographer

V. Biological Oceanography

  A. Limiting factors and marine environments (Benthic, Pelagic)
  B. Plant classification and animal classification
  C. Symbiosis
  D. Feeding levels and food chain (web)
  E. Productivity
  F. Instruments used by the marine biologist

VI. Marine Archaeology

  A. Techniques and equipment
  B. Artifacts

VII. Ocean Pollution:
  Raw sewage, solid wastes, heavy metals, thermal pollution, carbon dioxide, dredging and landfill, pesticides, military dumping, radioactive wastes, oil pollution

VIII. Oceans for Survival

- A. Fishing and aquaculture
- B. Natural gas and oil
- C. Other energy sources: thermal, damming, tidal power, currents, waves, and biomass energy

IX. Recreation

- A. Problems associated with diving
- B. Diving terminology
- C. Diving in the future

X. Transportation and Underwater Vehicles

XI. Living in the Oceans: Undersea Habitats

XII. Laws of the Sea

Suggested Activities
Grade 8
Earth Science
Unit: Oceanography

OBJECTIVE: To plot on a graph the actual data of sounded points along the Atlantic from New Jersey to Portugal; to describe the ocean profile obtained after graphing

TITLE: "Sounding"

SOURCE: Interaction of Earth and Time. Problems 1 and 2, pp. 136-137.

OBJECTIVE: To graph and define the effect of salinity on the density of water and to interpolate the density of sea water

TITLE: "Salinity and Density"

SOURCE: Interaction of Earth and Time. Investigation 6.2, p. 113.

OBJECTIVE: To graph and define the effect of temperature on the density of water; to describe how oceanic currents are affected by temperature differences

TITLE: "Temperature and Density"

SOURCE: Interaction of Earth and Time. Investigation 6.3, p. 114.

OBJECTIVE: To graph actual data of average ocean surface temperatures and average percentage of salinity according to latitude; to deduce which latitudes have the greatest densities of surface waters; to graph average temperature versus depth in meters and infer the location of the thermocline

TITLE: "Graphing Salinity Versus Latitude; Temperature Versus Latitude; Temperature Versus Depth"

SOURCE: Interaction of Earth and Time. Pp. 119-124.

OBJECTIVE: To graph actual data of daily, monthly, and yearly tides; to identify the flood tides; ebb tides; periods of the new, full, and quarter moons; days and months of great tidal ranges; to identify patterns in tidal cycles

TITLE: "Tides"

SOURCE: Teacher developed from data obtained from San Diego Tide Charts

OBJECTIVE: To identify marine organisms

TITLE: "Organism Lab"

SOURCE: Teacher developed. Organisms were collected in Hawaii, California, and Florida.

OBJECTIVE: To arouse interest in marine sciences; to discover scientific information concerning a variety of marine topics

TITLE: "Mini-Units"

SOURCE: Teacher developed from a variety of sources

OBJECTIVE: To participate in a simulation game of the United Nations Law of the Sea Conference; to discover the problems involved with 150 countries trying to come to agreement about territorial limits, fishing and mineral rights, and pollution controls

TITLE: "Law of the Sea"

SOURCE: Leimas, Carol, U.N. Representative. "Scenario-Model United Nations Conference on the Law of the Sea." American Association of University Women, 2401 Virginia Avenue, N.W., Washington, D.C. 20037.

OBJECTIVE: To see various types of diving equipment: mask, snorkel, wet suit, flippers, tank, weight belt, regulator, depth gauge, knife, slurp gun, camera

TITLE: "Diving Equipment"

SOURCE: Teacher prepared demonstration

Resources
Grade 8
Earth Science
Unit: Oceanography

Text Materials

Abraham, Norman; Chaney, Donald; Moores, Michael; Swift, Robert; and Notkin, Jerome J. Interaction of Earth and Time. Rand McNally and Company, 1972.

Emmens, C.W. The Marine Aquarium in Theory and Practice. T.F.H. Publications, Inc., 1975.

Harris, Miles F.; Hesser, Dale T.; Hynek, J. Allen; et al. Investigating the Earth. Houghton Mifflin Co., 1973.

Jackson, Joseph H., and Evans, Edward D. Spaceship Earth. Houghton Mifflin Co., 1973.

Leach, Susan. Oceanography. Unpublished, 1977.

Ramsey, William L.; Burckley, Raymond A.; Phillips, Clifford R.; and Watenpaugh, Frank M. Modern Earth Science. Holt, Rinehart, and Winston, Inc., 1973.

Films

The Beach -- A River of Sand, Columbus Public Library

Japan Harvests the Sea, Westerville Public Library, Bexley Public Library, Columbus Public Library

Mysteries of the Deep, Westerville Public Library, Bexley Public Library, Columbus Public Library

This Land, Shell Film Library, 1433 Sadlier Circle, West Drive, Indianapolis, Indiana, 46239.

Undersea Oasis, Shell Film Library, 1433 Sadlier Circle, West Drive, Indianapolis, Indiana, 46239.

Filmstrips

Bathymetric Features, Hastings Career Center

The Biological Environment, Hastings Career Center

Man Uses the Ocean, Hastings Career Center

The Ocean and the World Ecosystem, Hastings Career Center

Filmstrips (Cont.)

Ocean Frontier, Hastings Career Center

The Physical Environment, Hastings Career Center

Shark, Hastings Library

Slides

Teacher prepared on shore erosion, organisms, ocean research vessels and instruments, and ocean pollution

Aquaria

55 gallon and 20 gallon aquaria are stocked with saltwater organisms in Room 218 at Hastings.

Exemplary Activity
Grade 8
Earth Science
Unit: Oceanography

OBJECTIVE: To graph actual data of daily, monthly, and yearly tides; to identify the flood tides; ebb tides; periods of the new, full, and quarter moons; days and months of great tidal ranges; to identify patterns in tidal cycles

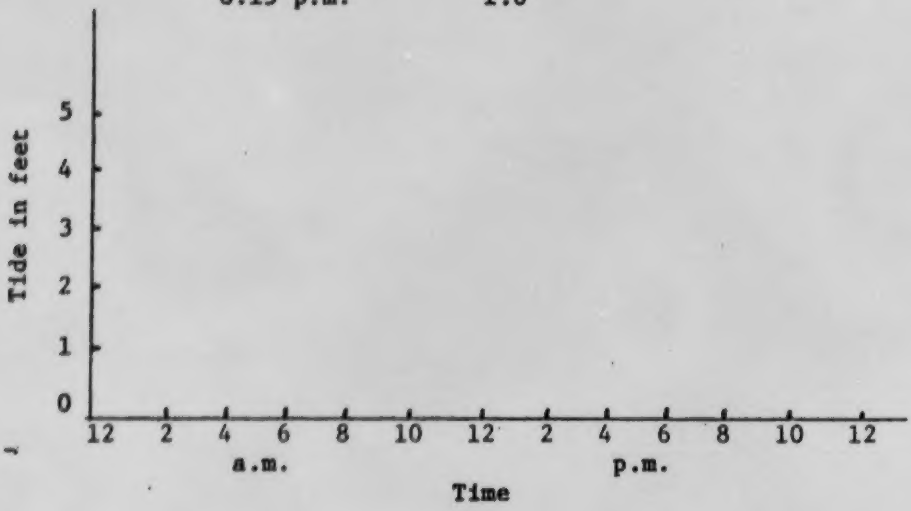
MATERIALS AND EQUIPMENT: Graph paper and pencils

PROCEDURE:

Use graph paper. Set up your graphs as I have shown. Plot all graphs in pencil -- pen graphs will not be accepted. Answer all questions in complete sentences!

A. Plot the following data: Daily tide; broken line graph; January 1, 1974

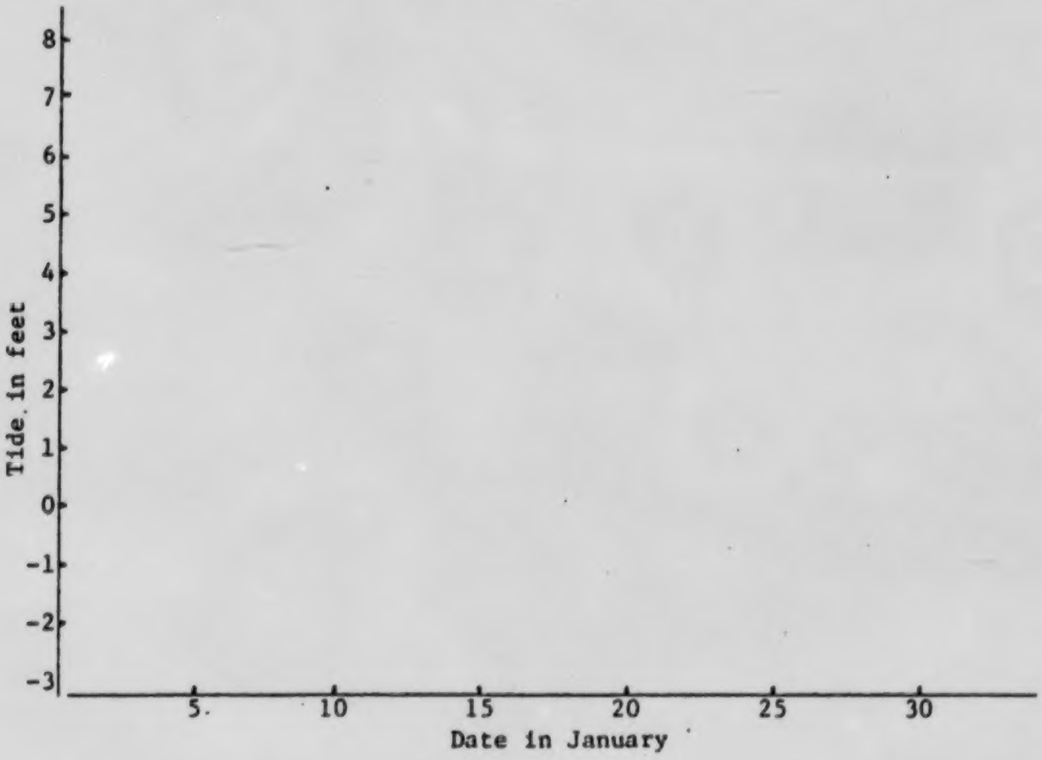
Time	Tide in feet
2:31 a.m.	4.7
9:21 a.m.	2.1
2:28 p.m.	3.2
8:15 p.m.	1.6



Exemplary Activity (Cont.)
Grade 8
Earth Science
Unit: Oceanography

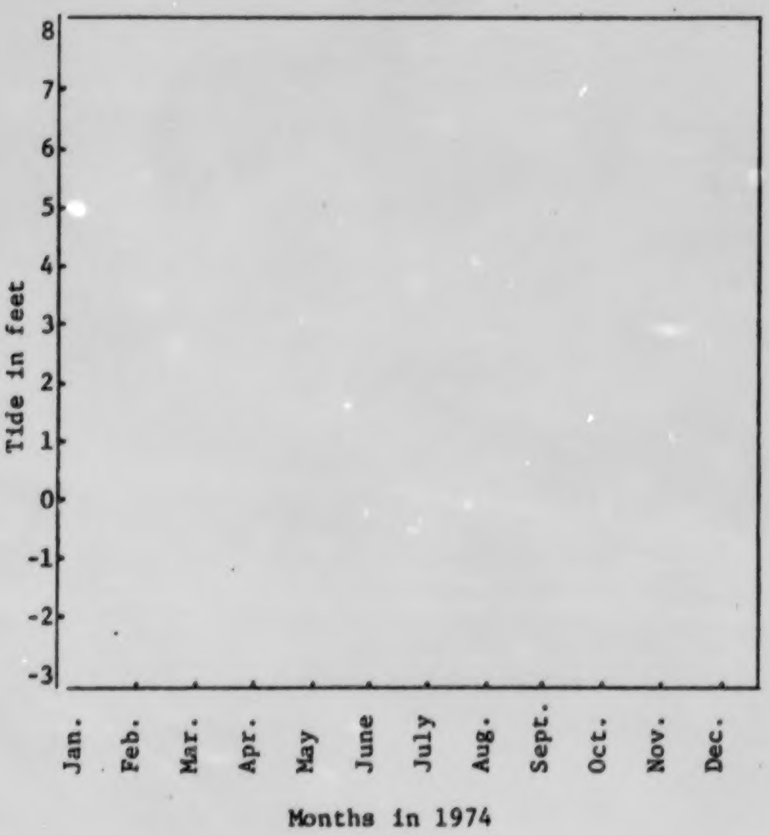
B. Plot the following data: Monthly tide; broken line graph; January 1-31, 1974. Plot high tide with a red pencil and low tide with a blue pencil. Only the highest flood tide and the lowest ebb tides are included for each day.

Date	High tide	Low tide	Date	High tide	Low tide
1	4.7	1.6	17	5.6	.2
2	5.1	1.4	18	5.8	- .2
3	5.5	.5	19	6.0	- .5
4	6.1	- .3	20	6.2	- .7
5	6.7	-1.1	21	6.3	- .8
6	7.2	-1.7	22	6.3	- .8
7	7.6	-2.0	23	6.3	- .7
8	7.7	-2.1	24	6.1	- .6
9	7.5	-1.9	25	5.8	- .3
10	7.0	-1.5	26	5.4	0.0
11	6.2	- .8	27	4.8	.4
12	5.3	- .1	28	4.2	.9
13	5.3	.6	29	4.9	1.4
14	5.3	1.4	30	5.0	1.5
15	5.3	1.2	31	5.1	1.1
16	5.4	.7			



C. Plot the following data: Yearly tide; bar graph; January-December 1974. Plot high tide with a red pencil and low tide with a blue pencil.

Month	High tide	Low tide
Jan.	7.7	-2.1
Feb.	7.3	-1.8
Mar.	6.6	-1.3
Apr.	6.4	-1.0
May	6.9	-1.6
June	7.4	-1.8
July	7.6	-1.7
Aug.	7.4	-1.3
Sept.	6.8	- .7
Oct.	7.1	- .9
Nov.	7.2	-1.3
Dec.	7.4	-1.7



Questions:

Graph A --

1. At what times were the flood tides?
2. At what times were the ebb tides?
3. Describe in words the shape of your graph.

Graph B --

1. What days would you suspect might have occurred during a full moon or a new moon?
2. What days would you suspect might have occurred during quarters of the moon?
3. What day had the greatest tidal range?
4. What day had the lowest tidal range?
5. Did there seem to be any pattern to your graph? Explain.

Graph C --

1. What month seemed to have the greatest flood tides?
2. What month seemed to have the lowest ebb tide?
3. What month had the greatest tidal range?
4. What month had the lowest tidal range?
5. Did there seem to be any pattern to your graph? Explain.

Teacher Developed

Evaluation Sample
Grade 8
Earth Science
Unit: Oceanography

History of Oceanography and Introduction to Ecological Oceanography

Name ______________________________ Period ____ Date __________

Score ________/80

Multiple choice (worth 2 points each):

____ 1. The belief that planets originated as a star passed close by another star and gravity pulled away material is (a) the gas-cloud theory (b) nebula theory (c) the tidal theory (d) the star explosion theory.

____ 2. The seas covering Ohio were generally (a) cold and shallow (b) warm and shallow (c) cold and deep (d) warm and deep.

____ 3. A (An) __?__ is big enough to be bounded by continents. (a) sea (b) gulf (c) ocean (d) cove

____ 4. The most southern ocean is the (a) Atlantic (b) Pacific (c) Indian (d) Southern.

____ 5. The ocean with the deepest trenches and the greatest volume of water is the (a) Atlantic (b) Indian (c) Pacific (d) Southern.

____ 6. When an organism dissolves and its structure is replaced by minerals from the water, the process is called (a) amber (b) alteration (c) coprolite (d) boring.

____ 7. Oceans cover (a) less than 50% of the surface of the Northern Hemisphere (b) less than 50% of the Southern Hemisphere (c) a greater percentage of the Northern Hemisphere than the Southern (d) a greater percentage of the Southern Hemisphere than the Northern.

____ 8. The best-accepted theory as to the creation of the planets is (a) the tidal hypothesis (b) the Leach legend (c) the star explosion theory (d) the nebular hypothesis.

____ 9. This body of water was created after the rift valley separated the continents: (a) Buckeye Lake (b) Atlantic (c) Pacific (d) Sea of Japan.

____10. A subduction zone does not include (a) trenches (b) rift valleys (c) mountains (d) volcanoes.

Evaluation Sample (Cont.)
Grade 8
Earth Science
Unit: Oceanography

Matching (worth 2 points each):

K Alexander the Great
L Benjamin Franklin
M Matthew Maury
N Cousteau and Gagnan
O Homer

P H.M.S. Challenger
Q Aristotle
R Oceanus
S Leonardo di Vinci
T Alfred Wegener
U Plato

____ 1. the father of oceanography

____ 2. developed the SCUBA tank

____ 3. discovered and named the Gulf Stream

____ 4. made a primitive snorkel and diving bell

____ 5. developed the theory of continental drift

____ 6. described Atlantis

____ 7. made the first known attempt at sounding the oceans

____ 8. wrote the first book that described sea monsters

____ 9. was the first to try out a diving bell

____10. made diving helmets, flippers, and snorkels

Matching (worth 2 points each):

K 71%
L 2.35 miles
M 85%
N 1%
O 97%

P 4.5 billion years
Q 10 billion years
R 3.5 billion years
S 7 miles
T 200 million years

____ 1. the average depth of the oceans

____ 2. the age of the earth according to geological oceanographers

____ 3. the amount of the earth's surface covered by oceans

____ 4. the amount of man's food that is provided by oceans

____ 5. the amount of time that the continents have been drifting

Evaluation Sample (Cont.)
Grade 8
Earth Science
Unit: Oceanography

Matching (worth 2 points each):

M manatee
N gastrolith
O coprolite
P coelacanth
Q overkill
R kraken
S Santorini
T bathyscaph
U topography
V biology
W physics
X trilobite

____ 1. the study of land formations

____ 2. giant squid

____ 3. underwater research vessel

____ 4. fossilized waste product

____ 5. sea cow, once thought to be a mermaid

____ 6. now extinct animal that crawled along the shallow Ohio ocean bottom

____ 7. the study of life

____ 8. island that is thought perhaps to be Atlantis

____ 9. rock that a dinosaur used in order to digest food

____10. the study of waves and motion

Essay: Write your answers in complete sentences (worth 10 points).

1. (a) Why don't all countries want to adopt the policy of the 200 ocean mile limit? (3 reasons)
   (b) Why do some countries want to adopt the policy of the 200 ocean mile limit? (3 reasons)
   (c) What is the law of the sea conference?
   (d) What did the United States decide to do about its territorial waters?

2. (a) What is a fossil?
   (b) How might a fossil form? (Give details! Draw pictures! Discuss words like: alteration, amber, ice, asphalt, mold, cast, gastrolith, coprolite, limestone, shale, etc.)

Unit Outline
Grade 8
Earth Science
Unit: Energy

I. Causes of the Crisis

   A. Government
   B. Oil companies
   C. Individuals

II. Energy Sources

   A. Types and availability
   B. Cost
   C. Environmental effects
   D. How it is used

III. Alternatives for the Future

   A. Coal re-examined
   B. Nuclear energy
   C. Solar energy
   D. Geothermal energy

Suggested Activities
Grade 8
Earth Science
Unit: Energy

OBJECTIVE: To explore how energy is used by a household, how it can be conserved, and the outlook for the future

TITLE: "The Household Energy Game"

SOURCE: Smith, Thomas W., University of Wisconsin Sea Grant College Program

OBJECTIVE: To trace the energy flow in the manufacturing, distribution, and use of a throwaway container

TITLE: "Energy Consumption/Conservation in Container Use and Transportation"

SOURCE: Award Winning Energy Education Activities, p. 21

OBJECTIVE: To enumerate factors that affect solar heating; to make generalizations about collecting and storing solar energy

TITLE: "Solar Heating and Cooling"

SOURCE: Award Winning Energy Education Activities, p. 32

OBJECTIVE: To separate and analyze some pollutants that may be found in the air

TITLE: "Identifying Solid Materials in the Air"

SOURCE: Namowitz. Earth Science Activities, pp. 151-152

OBJECTIVE: To observe how smoke affects the growth of a plant

TITLE: "Observing the Effects of Smoke on Plants"

SOURCE: Namowitz. Earth Science Activities

Resources
Grade 8
Earth Science
Unit: Energy

Text Materials

Namowitz, Samuel N. Earth Science Activities. American Book Company, 1978.

Films -- Available from DOE TIC Film Library, Oak Ridge Turnpike at Athens Road, P.O. Box 62, Oak Ridge, TN 37830

Controlling Atomic Energy, K 96

The Endless Chain, A 457

Energy -- The American Experience, B 507

Here Comes the Sun, B 499

Nuclear Power and the Environment, A 447

Power From the Earth, B 501

When the Circuit Breaks, K 503

Filmstrips -- Hastings Library

Causes of Crisis

The World of Energy

Pamphlets

Energy Factsheets. DOE Technical Information Center, P.O. Box 62, Oak Ridge, TN 37830.

Oil, Coal, and Uranium: Do They Mix? Public Relations Department, Continental Oil Co., High Ridge Park, Stanford, CT 06904.

Articles

Schlosser, Philip A. "Energy Primer," News in Engineering, March 1978.

Supplementary Materials

An Educator's Guide to the Three E's: Energy/Ecology/Economics. Consumer Information Services, Sears, Roebuck and Co., D/703 Sears Tower, Chicago, IL 60684.

Transportation and the City, Grades 8, 9. NSTA Interdisciplinary Units, U.S. Department of Energy, Technical Information Office, P.O. Box 62, Oak Ridge, TN 37830.

What Can You Make From Energy? 1978. Union Carbide Corporation, 270 Park Avenue, New York, NY 10017.

Exemplary Activity
Grade 8
Earth Science
Unit: Energy

Reference:

Smith, Thomas W. "The Household Energy Game," University of Wisconsin Sea Grant College Program.

Evaluation Sample
Grade 8
Earth Science
Unit: Energy

Part I. Fill in the blanks.

1. The two largest uses of energy by a family in the U.S. are ______________

2. and ________________.

3. If you wanted to transport the largest number of people a given distance with the least fuel waste, the choice for transportation would be

   automobile   bus   airplane. (Circle your choice.)

4. Describe two measures that your family could take to decrease their energy consumption at home.

   a.

   b.

5. Which country uses the greatest amount of energy? ____________________

6. What part of U.S. society uses the greater portion of energy --

   commercial,   transportation,   residential? (Circle your choice.)

7. The fossil energy source consumed most by people in the U.S. is

   ____________________.

8. Which energy source supplies most of the fuel for transportation?

   ____

9. Our most plentiful fossil fuel is ______________.

10. Gasoline is obtained from the fossil fuel __________.

Part II. Essay

Your answers will be graded according to their accuracy, completeness, and legibility. All answers are to be placed on the blank sheets provided.

1. Government, oil companies, and individual consumers are often cited as being contributors to the energy crisis. Give two reasons why each may be considered as causes of the crisis.

2. Several effects of the energy crisis are presently being felt, and other effects will become apparent in the future. Describe at least three effects currently being felt and three probable effects in the future. Consider such segments of society as government, industry, and residential users.

3. Several fuels have been suggested as possible energy sources for the future. Each of these fuels has certain advantages and disadvantages related to such things as supply, effect on the environment, cost, and present status of research and development (technology). Take the following fuels and describe advantages and disadvantages seen in their use.

   A. coal
   B. solar energy
   C. geothermal energy
   D. nuclear energy

4. To make our current fuel sources last longer, individuals could practice conservation measures. Describe four ways that you (not your parents or others) could help make our fossil fuel resources last longer.

Unit Outline
Grade 8
Earth Science
Unit: Discovering With Instruments

I. Use of Scientific Instruments

   A. Optical telescope
   B. Geiger counter
   C. Spectroscope
   D. Breathalyzer
   E. Other selected instruments

II. Function of Scientific Instruments

   A. Optical telescope
   B. Geiger counter
   C. Spectroscope
   D. Breathalyzer
   E. Other selected instruments

III. Value of Scientific Instruments

   A. Man's dependence on instruments
   B. Common characteristics of instruments
   C. Specific applications of instruments in data acquisition

Suggested Activities
Grade 8
Earth Science
Unit: Discovering With Instruments

OBJECTIVE: To use a spectroscope to observe continuous and bright-line spectra

TITLE: "Investigating with a Spectroscope"

SOURCE: Teacher developed

OBJECTIVE: To examine a refractor telescope and a reflector telescope and determine how they function

TITLE: "Optical Telescopes"

SOURCE: Teacher developed

OBJECTIVE: To understand the structure of the atom, the nature of radioactive material, and how a geiger counter detects radiation

TITLE: "The Atom and the Geiger Counter"

SOURCE: Teacher developed

OBJECTIVE: To demonstrate the technique, procedures, and principles involved in testing individuals for alcoholic content

TITLE: "Alcohol and the Breathalyzer"

SOURCE: Teacher developed

OBJECTIVE: To determine relative humidity using a sling psychrometer

TITLE: "A Hot, Sticky, Muggy Summer Day"

SOURCE: Teacher developed

OBJECTIVE: To draw a line representing the shape of the ocean floor from data collected from an echo sounder

TITLE: "Mapping the Ocean Floor"

SOURCE: Teacher developed

OBJECTIVE: To review the parts and function of the microscope

TITLE: "Understanding the Compound Microscope"

SOURCE: Teacher developed

Resources
Grade 8
Earth Science
Unit: Discovering With Instruments

Text Materials

Abraham, Norman; Chaney, Donald; Moores, Michael; Swift, Robert; and Notkin, Jerome J. Interaction of Earth and Time. Rand McNally and Company, 1972.

Harris, Miles F.; Hesser, Dale T.; Hynek, J. Allen; et al. Investigating the Earth. Houghton Mifflin Co., 1973.

Jackson, Joseph H., and Evans, Edward D. Spaceship Earth. Houghton Mifflin Co., 1973.

Ramsey, William L.; Burckley, Raymond A.; Phillips, Clifford R.; and Watenpaugh, Frank M. Modern Earth Science. Holt, Rinehart, and Winston, Inc., 1973.

Films

Atomic Energy: Inside the Atom -- Columbus Public Library

Light and Color -- Columbus Public Library

Measurement and Man -- Indiana University

Measurement in Physical Science -- Indiana University

Story of Palomar -- Indiana University

Exemplary Activity
Grade 8
Earth Science
Unit: Discovering With
Instruments

OBJECTIVE: To examine a refractor telescope and a reflector telescope and determine how they function

MATERIALS AND EQUIPMENT: Refracting telescope; reflecting telescope

INTRODUCTION: Every telescope, whether it be a homemade instrument or one of the giants of the western observatories, operates in essentially the same manner. It gathers a part of the light produced by, or reflected from, an object or objects, and concentrates this light in a single area -- the focal plane. The image, which forms at the focal plane at the prime focus, is magnified by means of an eyepiece.

The part of the telescope that gathers the light is called the objective. In the reflecting telescope, the objective is a curved (concave) aluminized mirror. The rays of light from the object to be viewed are reflected from the mirror surface directly to the eyepiece, or are picked up by the eyepiece after being reflected from a flat secondary mirror.

In the simple refracting telescope, or refractor, the light rays are bent toward the focal plane as they pass through a curved (convex) lens. This lens serves the same purpose as the concave mirror of the reflector, although it is usually referred to as an object glass instead of an objective.

No matter what the type of optical telescope, the basic principle is always the same. The cone of light from an object is reduced in diameter and is concentrated at the prime focus, where it can be examined by means of either a photographic plate or an eyepiece. The result is always a magnified image of the original object.

CHARGE: In completing this module, you will be working toward objectives of this unit by being able to:

1. discuss how the two types of optical telescopes work,
2. diagram and label the main parts of a refractor and a reflector, and
3. explain what the spectroscope and the optical telescopes have in common.

PROCEDURE:

1. Carefully examine the refracting telescope (the smaller of the two). Do NOT touch the glass surface of the lens or the eyepiece. Aim the telescope at a distant object out of the window.

Describe the object at which you are looking as you see it without the telescope.

How is the image formed through the telescope different from the image you see with your eyes?

Explain why the image is upside down.

In the space below, diagram the telescope from the side as if you could see through the tube. Label the objective lens, eyepiece, and prime focus. By using arrows, show the path of light through your diagram from an object to the observer's eye.

2. Carefully examine the reflecting telescope (the larger of the two in the classroom). Do NOT touch the glass surface of the eyepiece or the diagonal and secondary mirrors. Aim the telescope at the most distant object you can see out of the window.

Describe the object at which you are looking as you see it without the telescope.

How is the image formed through the telescope different from the image you see with your eyes?

Suggest a reason why the telescopic image of a close object is not clear or in focus. ______________________________

____

How might this situation be corrected? ______________________________

____

In the space below, diagram the telescope from the side as if you could see through the tube. Label the concave mirror, secondary or diagonal mirror, prime focus, and eyepiece. By using arrows, show the path of light from an object to the observer's eye.

Questions

1. Why do you suppose a reflecting telescope can be made larger than a refracting telescope? ______________________________

____

____

____

2. In what ways are the two optical telescopes alike? ______________________________

____

____

____

3. In what ways are the two optical telescopes different? ____________

____

____

____

4. If you had a choice and money were no object, which one of the two types of optical telescopes would you like to have to observe the heavens as an amateur?

____

Explain why. ____

____

____

____

Evaluation Sample
Grade 8
Earth Science
Unit: Discovering With
Instruments

I. Matching. The minimum number to complete on this section (A plus B) is 12. Your score on this part will be determined by the total number of blanks you complete.

Each of the words in the right hand column was used in at least one activity. (Hint: The first five words or numbers in each part are from required activities.) Match the phrase on the left to the word on the right. Each letter is used once or not at all. Print carefully, using UPPER CASE letters. Thank you!

Part A. Phrase

____ 1. The colors of the rainbow

____ 2. The elevation of Polaris in the Northern Hemisphere

____ 3. A derived score represented by three sets of numbers with three numbers in each set

____ 4. Enlarges the image

____ 5. To bounce off; to bounce back

____ 6. Naturally occurring; from outer space, mineral deposits, etc.

____ 7. A substance used to show the presence of a certain kind of chemical

____ 8. A line that represents geographic features

____ 9. The relationship of mass to the space occupied

____10. Makes things move or change

____11. The temperature at which water vapor changes from a gas to a liquid

Word

A. background radiation

B. condensation

C. density

D. dew point

E. energy

H. evaporation

I. eyepiece

K. indicator

M. latitude

O. nosepiece

T. prime focus

V. profile of topography

W. reflect

X. refract

Y. spectrum

Z. stanine

Evaluation Sample (Cont.)
Grade 8
Earth Science
Unit: Discovering With
Instruments

Part B. **Phrase**

____12. The line where the sky seems to meet the earth

____13. A form of energy used to determine the speed of a moving vehicle

____14. Breaks up light into colors

____15. The set of colors that you saw from a single gas in a tube that was heated by an electric current

____16. Collects light in a reflecting telescope

____17. Can seriously damage living organisms

____18. Another word for the weight of an object

____19. A part used to control the amount of light

____20. Describes what mercury does when the temperature drops

____21. The amount of space occupied by an object

____22. Essential for mapping the ocean floor

Word

A. bright-line spectrum
B. concave mirror
C. continuous spectrum
D. contracts
E. dark-line spectrum
H. diaphragm
I. diffraction grating
M. expands
O. gamma rays
P. horizon
S. mass
T. mr/hr
V. objective lens
X. radio waves
Y. sound waves
Z. volume

Evaluation Sample (Cont.)
Grade 8
Earth Science
Unit: Discovering With Instruments

II. Matching. The minimum number to complete is 13. (Hint: The first eleven blanks represent required activities.) Your score will be determined by the total number you get correct compared to the number of blanks you complete.

Which one of the instruments in the right hand column would be most useful in obtaining the information wanted in the left hand column? Each instrument is used once or more than once. There is only one correct and/or best answer for each number. Print carefully, using UPPER CASE letters. Thank you!

Information Wanted

____23. Is the distant galaxy moving toward the earth or away from the earth?

____24. The professor wants altitude information on stars from different locations in the Northern Hemisphere.

____25. Use with a camera to obtain a record of stars too dim to see with the unaided eye.

____26. A visual picture of sounds that we can and cannot hear

____27. What is the blood-alcohol content of this driver?

____28. How will Mrs. Harriott determine if you know the correct spelling of this week's words?

____29. Who borrowed (stole) the large lead weights that went with Mods K and L?

____30. What is the composition of the star nearest in distance to the sun?

____31. How large is the biggest crater on the side of the moon facing the earth?

____32. At what speed is Dusty driving his moped?

____33. Mrs. Farnsworth wants a more accurate indication of the learning ability of all students who received an A in science on the progress reports.

	Instrument
A.	Astrolabe
B.	Balance
BRJ.	Black Raspberry Jam solution
BR.	BReathalyzer
E.	Echo sounder
GE.	GEiger counter
GR.	GRaduated cylinder
L.	Lie detector
M.	Microscope
O.	Oscilloscope
RG.	Radar Gun
RA.	RAdiometer
RRT.	Reflecting/ Refracting Telescope
S.	Spectroscope
T.	A Test
TH.	THermometer

Information Wanted (Cont.)

____34. Are there any beta particles in Room 219?

____35. Which one of these three substances is a base?

____36. Is radiant energy present in Mrs. Farnsworth's supply closet?

____37. Place these three marbles of all the same size in order of increasing density.

____38. What is the shape of the ocean floor south of Florida?

____39. What is the number of animals in a drop of pond water?

____40. What is the dew point at 5:00 a.m. for each day of October?

____41. What is the volume of ten of the balls of the ball clock?

____42. This solution is either neutral or it is an acid.

III - VII. Use complete sentences in aswering numbers III, V, VI, and VII. You will be scored on your organization, clarity, accuracy, and completeness. You must use a different instrument in completing each one of the following numbers.

III. Describe how to use properly one of the instruments with which you worked.

____
(instrument)

Evaluation Sample (Cont.)
Grade 8
Earth Science
Unit: Discovering With
Instruments

IV. Diagram and label one of the instruments that you used. You will be scored on the clarity of your diagram and the accuracy and completeness of your labeling.

____
(instrument)

V. Describe how one of the instruments that you used works.

____
(instrument)

VI. Explain why we depend on instruments. Give at least one example as a part of your explanation, using an instrument with which you worked.

____
(instrument)

VII. Define the term "instrument" as used in this unit. Give at least one example as a part of your definition, using an instrument with which you worked.

____
(instrument)

Unit Outline
Grade 9
Physical Science R
Unit: Radiant Energy

I. Perception
   - A. Optical illusions
   - B. Factors related to illusions

II. Properties of Light
   - A. Straight line
   - B. Reflection
     - 1. Flat mirror
     - 2. Concave mirror
     - 3. Applications such as telescope, periscope, solar collector
   - C. Refraction
     - 1. Lenses, ray diagrams
     - 2. Prism
     - 3. Water-air interface

III. Image Formation
   - A. Pinhole camera
   - B. Using lenses
     - 1. Structure and function of the camera
     - 2. Structure and function of the eye
     - 3. Correcting vision
     - 4. Telescopes, microscopes

IV. Wave Theory
   - A. Properties and types of waves
   - B. Color
   - C. Electromagnetic spectrum
   - D. Lasers

Suggested Activities
Grade 9
Physical Science R
Unit: Radiant Energy

OBJECTIVE: To verify that perception is the interaction of sensory input and how your mind interprets it; to identify four factors that affect perception

TITLE: "Now You See It, Now You Don't"

SOURCE: Teacher developed from an article by Fred Attneave titled "Multistability in Perception," Scientific American, December 1971

OBJECTIVE: To arouse student interest in the investigation of the principles of reflection

TITLE: "Mirror, Mirror, on the Wall"

SOURCE: Teacher developed from the Elementary Science Study unit titled "Mirror Cards"

OBJECTIVE: To discover the characteristics of image formation in a plane mirror

TITLE: "An Investigation of Multiple Images"

SOURCE: Teacher developed from an article by Gordon Gore in The Science Teacher, February 1973, pp. 58-59

OBJECTIVE: To verify the principles of reflection

TITLE: "An Investigation of Images in a Plane Mirror"

SOURCE: Modified PSSC exercise

OBJECTIVE: To discover the relationship between object location and image formation

TITLE: "An Investigation of Image Formation by Convex Lenses"

SOURCE: Modified PSSC exercise

Suggested Activities (Cont.)
Grade 9
Physical Science R
Unit: Radiant Energy

OBJECTIVE: To discover the relationship between distance from a light source and illumination

TITLE: "Light Intensity"

SOURCE: Modified from the *Idea* Science Program, *Physical Science*, published by Steck-Vaughn

OBJECTIVE: To discover the ability of the human eye to perceive two separate points as separate points, not one point

TITLE: "Resolving Power"

SOURCE: Modified from a unit developed by the staff of the Villa Angela Academy, Cleveland, Ohio

OBJECTIVE: To identify what determines the colors of transparent and opaque objects

TITLE: "Color Investigation"

SOURCE: Unknown

Resources
Grade 9
Physical Science R
Unit: Radiant Energy

Text Materials

Brandwein, Paul F. Energy, A Physical Science. Harcourt, Brace, Jovanovich, 1975, pp. 386-433.

Hill and Barcaski. Spaceship Earth Physical Science. Houghton Mifflin Co., 1974, pp. 224-241.

Films -- Grandview Heights Public Library

The Laser Beam

The Unseen World -- Things Too Small

Filmstrips -- Hastings Library

Geometrical Optics -- Popular Science, 10-35

Mazers and Lasers -- Popular Science, 10-37

Photoelectric Effects -- Popular Science, 10-33

Transparencies -- Hastings Library

Optical Illusions

Reflection and Refraction of Light

Exemplary Activity
Grade 9
Physical Science R
Unit: Radiant Energy

OBJECTIVE: To investigate images formed in a mirror

MATERIALS AND EQUIPMENT: 1 candle, 4 "marker candles," hinged plexiglass sheets, circular graph paper or protractor

PROCEDURE:

Draw a line on the circular graph paper on the 0 to 180 degree axis. Mark the center of this line.

Measure 2 inches out from the center toward you on the 90 degree axis and make a mark. Light your candle and place it on this mark. This is object position one (label it).

Place your plexiglass sheet on the 0 to 180 degree line so that the hinge is about two inches to the left of your center mark. The plexiglass will make a straight line, not an angle. Look into the plexiglass and you will see an image (picture) of your candle.

Take a marker candle (do not light marker candles) and place it behind the plexiglass exactly where the image appears to be. Mark this as image position 1.

Move the object to a position 3 inches in front of the plexiglass. Mark this as object position 2. Place a marker candle behind the plexiglass where the image appears to be. Mark this as image position 2.

Record the following:

The distance from object position 1 to the plexiglass ____________

The distance from image position 1 to the plexiglass ____________

The distance from object position 2 to the plexiglass ____________

The distance from image position 2 to the plexiglass ____________

Can you make a general statement relating the distance of an object from a mirror to the distance that the image appears behind the mirror? ____________

Statement:

Now set the candle back on object position 1. Move the hinge of your plexiglass sheets so that it is directly over your center mark and arrange the plexiglass so that it makes a 120 degree angle (60° to the left of the candle and 60° to the right of the candle). How many images do you see?

____

Place marker candles behind the plexiglass where the images appear to be. Mark their location and mark the angle that is made by your plexiglass. Again check the distance from your object to the mirror and from the mirror to the image.

What did you find?

Is this consistent with the statement that you made earlier?

Set up a second sheet of graph paper just as you did in the beginning of this exercise. Place your object 2 inches from the center mark and set your plexiglass at a 90 degree angle (45° to the left of the candle and 45° to the right of the candle). How many images do you see?

____

Place marker candles behind the plexiglass where the images appear to be. Mark their location. View the whole setup from above. Do you see any pattern?

____

What is it?

Investigate the object and image distances any way that you want. Summarize your investigation and results below.

Summarize your findings thus far in the chart below.

degrees	number of images
180	
120	
90	

Can you find some mathematical way of predicting how many images will be seen at a certain angle? (Hint: There are 360 degrees in a circle.) Write your method of predicting in the space below.

Now predict how many images will be seen at 60 degrees (30° to the left of the candle, 30° to the right).

Prediction ________

Test your prediction. Results ________________

If you cannot discover the mathematical prediction, see your teacher.

Predict what will happen to the number of images as the angle between the mirrors approaches zero.

Prediction:

Test the above prediction by placing two mirrors parallel to each other with the object in between them.

Results:

What happens to the number of images when the angle between the two mirrors divided into 360 degrees does not give a whole number? Do you think that you will get a whole number of images anyway? Discover the correct answer and explain your method and the answer in the space below:

Optional: Using your observations from this lab, design a toy kaleidoscope. Build a kaleidoscope based on your design and/or obtain a toy kaleidoscope, tear it apart and see how it works.

*This lab was written from an article by Gordon Gore, The Science Teacher, February 1973, pp. 58-59.

Evaluation Sample
Grade 9
Physical Science R
Unit: Radiant Energy

Section I

Multiple choice: Choose the one best answer and record it on the blank at the left.

___ 1. A material through which light will not pass is termed a) translucent b) opaque c) transparent d) none of the above.

___ 2. The cells in the human eye that are sensitive to color are a) rods b) sclera c) cones d) choroid.

___ 3. The color of a light filter depends upon a) the light it reflects b) the amplitude of the light transmitted c) the light that bounces back d) the wavelength of the light that passes through it.

___ 4. The three additive primary colors are a) red, green, yellow b) red, blue, magenta c) blue, green, cyan d) red, blue, green.

___ 5. A room is illuminated by red light only. Which of the following objects would appear black? a) white b) yellow c) magenta d) blue

___ 6. Two colors that are complementary are a) red and magenta b) blue and cyan c) yellow and green d) none of the above.

___ 7. The image formed by your pinhole camera was not very clear. Which of the following properties of light was a contributing factor? a) refraction b) reflection c) diffraction d) travels in a straight line

___ 8. Which of the following is an example of a longitudinal wave? a) sound b) light c) pebble dropped in a pond d) none of the above

___ 9. That part of the eye that functions like the black backing on photographic film is the a) retina b) choroid c) lens d) iris.

___10. The size of the image formed by a plane mirror a) depends upon the size of the mirror b) depends on the size of the object c) cannot be estimated since the image is virtual d) is always the same in size.

___11. The inner coating of the eye on which images are formed is called the a) pupil b) iris c) cornea d) retina.

___12. An object forms an image of the same size when it is placed at a) beyond twice the focal distance b) between the primary focus and the optical center c) between the primary focus and twice the focal distance d) twice the focal distance of the convex lens.

___13. The property of waves whereby they bend as they move around an object is a) refraction b) reflection c) interference d) diffraction.

___14. The eye is automatically focused by changes in the a) optic nerve b) lens c) iris d) retina.

___15. The image on a movie screen is a) real b) virtual c) formed by a convex mirror d) formed by a plane mirror.

___16. As the sun sets, the atmosphere has a reddish glow because a) violet light is reflected more than red b) of refraction of light due to the earth's atmosphere c) less light is emitted by the sun d) all of the above.

___17. An incident ray of light strikes a plane mirror at an angle of 45 degrees. The angle between the incident and reflected rays is a) 22.5 b) 45 c) 90 d) 112.5 degrees.

___18. The bending of light rays as they pass from air into water is called a) reflection b) dispersion c) refraction d) radiation.

___19. A beam of parallel rays is reflected from a plane mirror. After reflection the rays will a) be diffused b) remain parallel c) diverge d) converge.

___20. The image formed by a plane mirror is a) smaller than the object b) inverted c) real d) as far behind the mirror as the object is in front of it.

___21. Lenses are devices that depend on a) refraction b) reflection c) diffusion d) absorption.

___22. As you read this question, a) the light is reflected from the paper to your eyes b) the light is reflected from your eyes to the paper c) the printed paper gives off light of its own d) your eyes produce the light needed to see the paper.

___23. A piece of red paper illuminated by white light looks a) white b) black c) violet d) red.

___24. Images formed by the eye lens are a) virtual b) magnified c) real d) erect.

___25. When a convex lens is used as a magnifying glass, the image is a) inverted b) real c) virtual d) reverses.

Evaluation Sample (Cont.)
Grade 9
Physical Science R
Unit: Radiant Energy

___26. The separation of white light into its component colors by a prism is called a) absorption b) reflection c) refraction for dispersion d) the transformation of energy.

___27. Light that is a mixture of all the colors of the spectrum of the sun is a) black b) red c) blue d) white.

___28. The color of light depends on its a) intensity b) amplitude c) wavelength d) speed.

___29. A convex lens a) makes the light rays spread out b) is opaque c) makes the light rays come to a point called the focus d) does not do anything to light rays.

___30. What do we call the part of the eye where the image is formed? a) retina b) lens c) optic nerve d) sclera

___31. An object that appears yellow in white light is reflecting a) blue and green b) red c) no colors at all d) red and green.

___32. A lens that spreads light out is called a) converging b) a magnifying glass c) diverging d) convex.

___33. When we mix blue light and green light we get a color called a) magenta b) cyan c) yellow d) turquoise.

___34. Red, blue and yellow are a) primary pigments b) primary colors of light c) combined to form yellow light d) all of the same wavelength.

___35. A convex lens has how many focal points? a) 1 b) 2 c) 3 d) an infinite number

___36. What energy change takes place in a TV camera? a) electromagnetic b) light to heat c) light to electric d) light to magnetic

___37. Which of the following may be used to determine distance? a) radar b) sonar c) laser d) all of the above

___38. White light passed through a prism creates a) coherent light b) incoherent light c) a spectrum d) all of the above.

___39. Which of the following may be harmful to you? a) light waves b) radio waves c) radar d) gamma rays

Evaluation Sample (Cont.)
Grade 9
Physical Science R
Unit: Radiant Energy

___40. Selective transmission is the principle of operation of which of the following? a) filters b) image orthicon tube c) radar d) sonar

___41. Light travels as what type of wave? a) longitudinal b) transverse c) intermittent d) all of the above

___42. Red and green light mixed together makes a) blue b) yellow c) magenta d) cyan.

___43. Which of the following waves can travel through space? a) light b) ultraviolet c) x-rays d) all of the above

___44. Light from a laser is a) many wavelengths b) coherent light c) traveling faster than regular light d) made up of many frequencies.

___45. Which of the following types of electromagnetic radiation travels the fastest? a) gamma rays b) x-rays c) radio waves d) none of the above

___46. The color of light depends on a) wavelength b) amplitude c) speed d) all of the above.

___47. As the wavelength increases, the frequency a) increases b) remains the same c) decreases d) they are not related.

___48. One example of a longitudinal wave is a) water wave b) sound wave c) light wave d) x-ray.

___49. A picture taken with a laser is called a) a laser photograph b) a coherent picture c) a holograph d) none of the above.

___50. As the frequency of a wave increases, the energy that it has a) increases b) remains the same c) decreases d) they are not related.

___51. Which of the following determines the focal length of a lens? a) diameter b) curvature c) circumference d) none of the above

___52. If you wanted to project an image larger than your object, you would place the object a) 1 focal length from the lens b) less than 1 focal length from the lens c) between 1 and 2 focal lengths from the lens d) beyond 2 focal lengths from the lens.

___53. The ASA number on photographic film refers to a) the amount of light needed to expose the film b) the size of the film c) the number of pictures on the film d) none of the above.

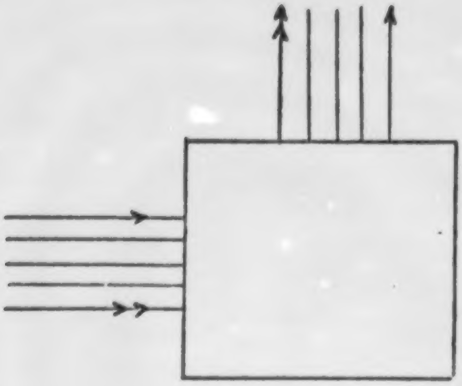
___54. The f- number on a camera refers to a) shutter speed b) aperture size c) distance to the subject d) film speed.

___55. Which of the following are properties of light produced by lasers? a) coherent b) one wavelength c) in phase d) all of the above

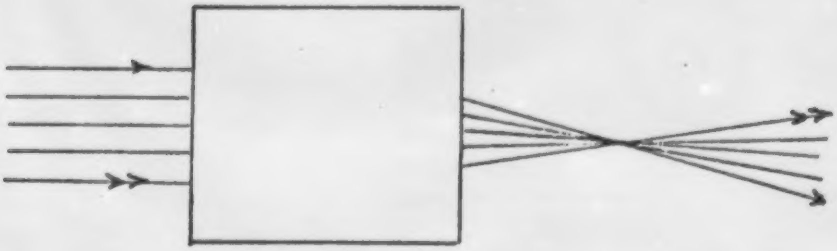
Evaluation Sample (Cont.)
Grade 9
Physical Science R
Unit: Radiant Energy

On the following problems, use any combination of lenses, mirrors, prisms, or glass blocks that are needed to get the desired effects.

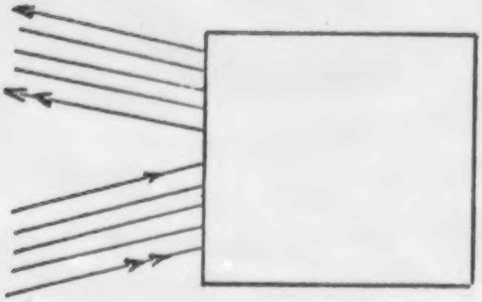
1.



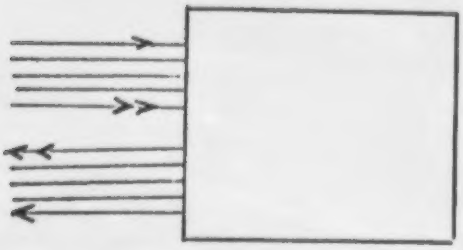
2.



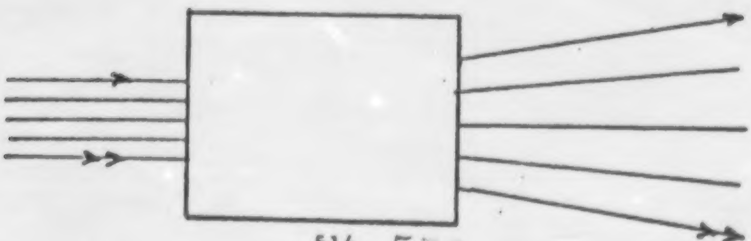
3.



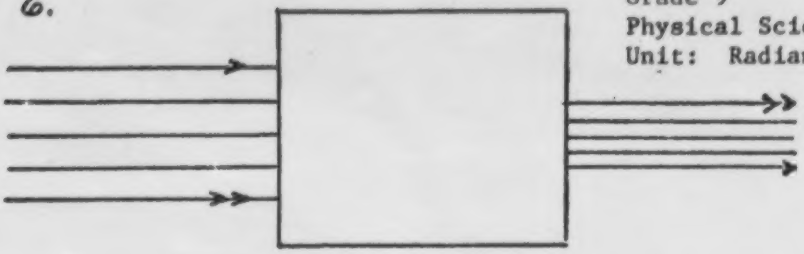
4.



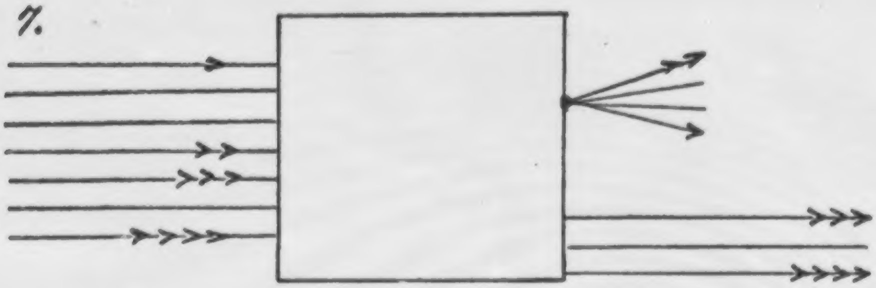
5.



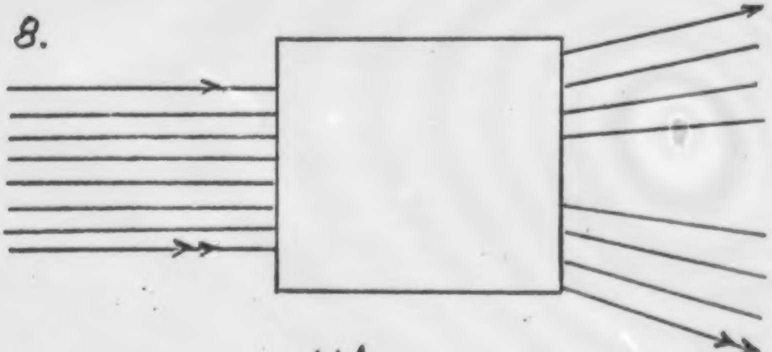
6.



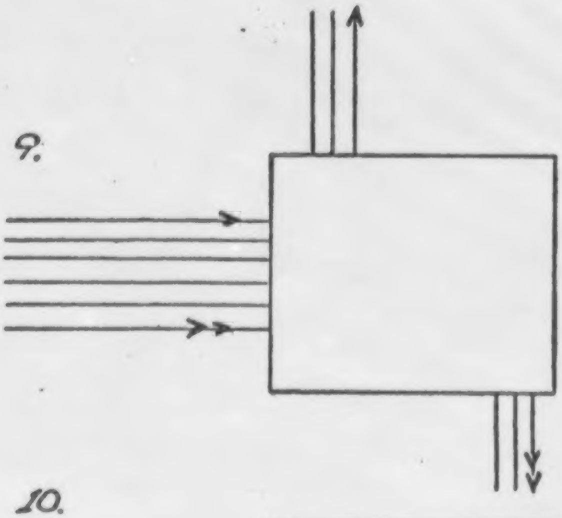
7.



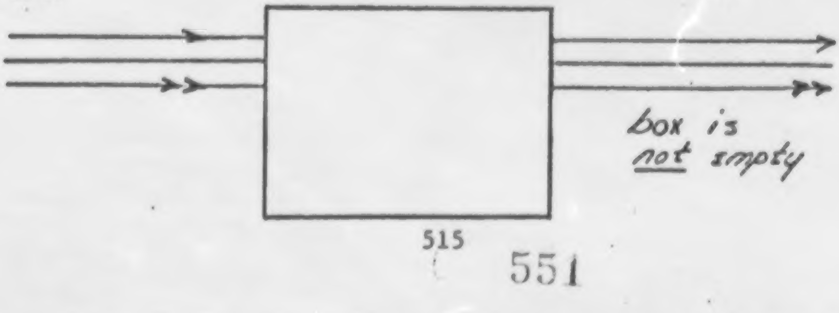
8.



9.



10.



box is
not empty

Unit Outline
Grade 9
Physical Science R
Unit: Magnetism and
Electricity

I. Static Electricity

   A. Atomic structure
   B. Law of charges
   C. Use of the electroscope
   D. Electric fields

II. Direct Current Electricity

   A. Dry cells and wet cells
   B. Ohms Law
   C. Series and parallel circuits

III. Magnetism

   A. Electromagnets and solenoids
   B. Permanent magnets
   C. Earth's magnetic field

IV. Alternating Current

   A. Energy transformations in generators and motors
   B. Electrical transmission and transformers
   C. Home safety devices and procedures

Suggested Activities
Grade 9
Physical Science R
Unit: Magnetism and Electricity

OBJECTIVE: To describe the method of charging and testing for charge of various objects

TITLE: "Behavior of Charged Things"

SOURCE: Spaceship Earth. Pp. 115-116.

OBJECTIVE: To explain how an electroscope is charged or discharged in terms of moving charges

TITLE: "Electroscopes"

SOURCE: Spaceship Earth. Pp. 121-122.

OBJECTIVE: To construct and diagram a simple electrical circuit

TITLE: "Simple Circuits"

SOURCE: Spaceship Earth. Pp. 134-138.

OBJECTIVE: To explain the correct procedure for connecting and reading a voltmeter and to demonstrate this knowledge using an actual circuit and diagram

TITLE: "Measuring Potential Difference"

SOURCE: Spaceship Earth. Pp. 140-141.

OBJECTIVE: To relate the characteristics of magnetic force and to describe one method for making a magnet

TITLE: "Magnetism"

SOURCE: Teacher developed

OBJECTIVE: To describe the fundamental relationship between electricity and magnetism

TITLE: "Electricity and Magnetism"

SOURCE: Spaceship Earth. Pp. 169-171.

OBJECTIVE: To compare circuit types, using operational definitions

TITLE: "Defining Circuits"

SOURCE: Teacher developed from Science, a Process Approach by AAAS

OBJECTIVE: To apply a method for testing the conductivity of various materials and to form operational definitions of the terms "conductor" and "insulator"

TITLE: "Conductors and Insulators"

SOURCE: Teacher developed from Science, a Process Approach by AAAS

OBJECTIVE: To observe and define operationally the function of a fuse in a circuit

TITLE: "Fuses"

SOURCE: Teacher developed from Science, a Process Approach by AAAS

OBJECTIVE: To measure current in a series circuit and apply Ohm's Law to the relationship of three circuit components

TITLE: "Current Series"

SOURCE: Teacher modified from Science, a Process Approach by AAAS, pp. 171-173

Resources
Grade 9
Physical Science R
Unit: Magnetism and
Electricity

Text Materials

Brandwein, Paul F., et al. Energy. Harcourt Brace Jovanovich, 1975.

Como, Victor. Physical Science, a Learning Strategy for the Laboratory. Charles E. Merrill Publishing Co., 1977.

Hill and Barcaski. Spaceship Earth, Physical Science. Houghton Mifflin Co., 1974, pp. 113-178.

Films

Electric Power Distribution. Jones Learning Center

Electric Power Generation. Jones Learning Center

Learning About Magnetism. Franklin County Library

Filmstrips -- Hastings Library

Distributing Electric Power

Power Sources of the Future

Supplementary Materials

Columbus and Southern Ohio Electric Company educational kits

Exemplary Activity
Grade 9
Physical Science R
Unit: Magnetism and
Electricity

OBJECTIVE: To construct an electromagnet and a solenoid, identify the north and south pole of each, and explain the factors that affect the strength of the magnetic field

MATERIALS AND EQUIPMENT: 30 paper clips, 1 nail (10 cm), 30 cm Cu wire (~18 gauge), 2 "D" cells in parallel, 4 compasses set up around room to test

PROCEDURE:

Using the materials at your table, you should do the following things. Wind the wire around a pencil or pen and leave about 10 cm of straight wire at each end. Now remove the pencil so that only the loops remain. The device you have just made is called a solenoid.

Decide which end of the solenoid you will attach to the negative end of the battery. Use the thumb rule to locate which end of the solenoid will be an N pole. Take the straight ends of the solenoid and touch them to the battery terminals. Be careful! The solenoid will probably get quite warm due to the current flowing through the wire. LEAVE BOTH WIRES CONNECTED TO THE BATTERY FOR VERY SHORT PERIODS OF TIME ONLY. The current used by the solenoid will drain the battery and make it go dead. Check your prediction by using one of the compasses in the room.

1. Was your prediction correct?
2. Is your solenoid strong enough to pick up a paper clip?
3. Now place a nail where the pencil was in the solenoid. What has this done to the strength of the magnetic field?

Technically, your solenoid became an electromagnet when you placed the nail in the coil. Use your electromagnet to solve the following problems.

4. Can the magnetic field of your electromagnet be turned on and off? If so, how?
5. Make a drawing of your electromagnet and battery to show the direction in which the wire is wound. Show the direction of current flow and label the N and S poles.
6. Note which end of your electromagnet is an N pole (use the compass if necessary). Carefully remove the battery and reverse its position. What effect does this have on the magnetic poles?

Now turn to Spaceship Earth, p. 176 and do each of the "team" items. Answer all of the questions on that page (7 questions in all) and number them as 7 through 13 in your writeup. Figure 8-22 shows you how to coil a wire in each case. Make sure the wire loops fit snugly against each other except where the book says to stretch them out.

Evaluation Sample
Grade 9
Physical Science R
Unit: Magnetism and
Electricity

Choose the best answer and use capital letters.

____ 1. A piece of paper is rubbed with vinyl plastic and a piece of vinyl plastic is rubbed with a hand. When the two rubbed items come near each other, they (A) have no effect on each other (B) repel (C) attract (D) bring their opposite magnetic poles together.

____ 2. Which of the following statements about electric charge is true? (A) Only substances containing plastic can be charged. (B) Only substances containing glass can be charged. (C) Many different substances can be charged. (D) Substances containing glass or plastic cannot be charged.

____ 3. If a strip of paper is rubbed with a piece of vinyl plastic, the strip of paper will (A) attract another piece of paper rubbed by vinyl plastic (B) repel another paper rubbed by vinyl plastic (C) repel a charged strip of vinyl plastic (D) have no effect on a charged piece of vinyl plastic.

____ 4. When a vinyl plastic strip is rubbed with your hand, the vinyl strip (A) will pick up bits of paper (B) becomes charged (C) becomes magnetic (D) both A and B.

____ 5. If a plastic comb is rubbed hard in your hair, the comb will (A) repel tiny bits of paper (B) attract tiny bits of paper (C) attract a north magnetic pole (D) repel a north magnetic pole.

____ 6. We say a charged hard rubber rod is negative because (A) the charge really is negative (B) hard rubber is naturally negative (C) Benjamin Franklin defined the charge on a hard rubber rod as being negative (D) negative charges can be seen on the rod with powerful microscopes.

____ 7. Object #1 is charged positively, and object #2 is repelled when brought close to #1. We can most correctly say that #2 is (A) positive (B) negative (C) neutral (D) charged opposite to #1.

____ 8. Two different materials are charged by rubbing. When brought close together, the two materials attract each other, so we would be most correct in saying that the two materials have (A) different charges (B) like charges (C) positive charges (D) negative charges.

____ 9. When we say an object is neutral, we mean that the object has (A) no protons (B) no electrons (C) both A and B (D) equal numbers of protons and electrons.

Evaluation Sample (Cont.)
Grade 9
Physical Science R
Unit: Magnetism and
Electricity

____10. An object is charged if it has (A) protons (B) more protons than electrons (C) electrons (D) neutrons.

In this section, if a charged electroscope is mentioned, assume that it is half charged (numbers 11 through 15).

____11. When a positively charged electroscope is discharged, what happens? (A) Negative charges move onto the electroscope. (B) Positive charges move off the electroscope. (C) The leaves go apart. (D) The leaves are not affected.

____12. What happens when a neutral pencil is brought near a positively charged electroscope? (A) Leaves go apart. (B) Leaves come together. (C) First B, then A (D) Nothing happens.

____13. What happens when a charged body comes near a neutral electroscope? (A) Leaves are unaffected. (B) Leaves repel if the body is negative. (C) Leaves attract if the body is positive. (D) Either B or C

____14. If a negative body touches a neutral electroscope, (A) electrons go from the electroscope to the body (B) the electroscope's leaves go apart (C) protons go from the body to the electroscope (D) both A and C.

____15. What happens when a positive body is brought near a negatively charged electroscope? (A) Electrons go from the leaves to the knob. (B) Protons go from the leaves to the knob. (C) The leaves move apart. (D) The leaves change color and drop.

____16. In electricity a source is a (A) switch (B) resistor (C) battery (D) any of these things.

____17. The correct way to connect a wire around a screw is to bend the wire (A) clockwise around the screw (B) counterclockwise around the screw (C) up over the screw (D) down under the screw.

____18. In the circuit you set up yesterday, the load was the (A) alligator clips (B) lamp (C) switch (D) dry cell.

____19. In the diagram on the board, which letter labels the lamp?

____20. In the diagram on the board, item D is the (A) switch (B) resistor (C) connecting wire (D) none of these.

____21. In the circuit diagram on the side board, when the switch is closed, the voltage across the lamp is (A) twice the battery voltage (B) equal to the battery voltage (C) zero volts (D) half the battery voltage.

____22. What is the reading on the voltmeter scale shown on the side board? (A) 1.5v (B) 1.4v (C) 1.6v (D) 1.25v (E) .6v

____23. To measure the voltage of a battery, which end of the voltmeter should be connected to the battery's negative terminal? (A) Positive end (B) Neutral end (C) Red wire (D) Either end, it makes no difference (E) Negative end

____24. In the circuit diagram on the side board, which voltmeter is in the proper position to make a voltage measurement when the switch is closed? (A) #1 only (B) #2 only (C) #1 or #3 (D) #2 or #4 (E) #1, #2, #3, #4

____25. A volt is the (A) rate of electron flow (B) energy per unit of charge (C) resistance in a circuit (D) rate of proton flow (E) measure of current.

____26. Which of the following statements about magnetism is true? (A) N poles attract S poles. (B) N poles attract N poles. (C) S poles attract S poles. (D) Both B and C

____27. Which part of a magnet exerts the most force? (A) Ends (poles) (B) middle (C) top (D) bottom

____28. A magnet can pick up (A) lead (B) copper (C) iron (D) all metals.

____29. A magnet can attract a paper clip through (A) paper (B) glass (C) copper (D) all of these.

____30. A steel paper clip can be magnetized by (A) stroking it in one direction with a magnet (B) dropping it on a hard surface (C) stroking it back and forth with a magnet (D) either B or C.

____31. The shape of the magnetic field around a current-carrying copper wire is (A) circular (B) square (C) rectangular (D) no shape since copper is not magnetic.

____32. Which statement is true? (A) Any electric charge has a magnetic field. (B) All magnets have electric fields around them. (C) Electricity and magnetism are not related. (D) Any moving electric charge has a magnetic field around it.

Look at the diagram on the chalkboard for questions 33, 34, and 35. The dot represents a wire carrying an electron current. Assume that you are looking at the drawing from in front of the chalkboard and use the following choices to answer 33, 34, and 35.

(A) left (B) right (C) down (D) up (E) compass needle unaffected

____33. If the direction of the current is out of the chalkboard, in what direction will a compass needle at X point?

____34. If the direction of the current is out of the chalkboard, in what direction will a compass needle at Y point?

____35. If the current direction is into the chalkboard, in what direction will a compass needle at Y point?

Unit Outline
Grade 9
Physical Science R
Unit: Motion

I. Forces
    A. Types
    B. Measurement
    C. Forces as vectors
        1. Principles
        2. Predicting resultants

II. Measurement of Motion
    A. Speed
    B. Velocity
    C. Acceleration
    D. Freely falling bodies

III. Newton's Laws of Motion
    A. First Law
    B. Second Law
    C. Third Law

OBJECTIVE: To study the effect of increasing gravitational pull on an elastic object

TITLE: "Force Measurement"

SOURCE: Developed by G. Sweitzer, modified by R. Leininger

OBJECTIVE: To determine factors that affect the force of friction

TITLE: "Force of Friction"

SOURCE: Adapted from Hoover, Korb, et al. Force and Motion. Board of Education, Baltimore Co., 1970.

OBJECTIVE: To study the effect of changes in the mass of the bob, the starting position, and the length of the pendulum on the period of a pendulum

TITLE: "Study of a Pendulum"

SOURCE: Teacher developed and modified over a period of time

OBJECTIVE: To predict and then test the motion of a disc acted upon simultaneously by more than one force. This activity is done as an adjunct to the study of forces as vectors.

TITLE: "Resultants of Forces"

SOURCE: Teacher developed

OBJECTIVE: To provide visual verification of the laws of motion

TITLE: "Newton's Laws of Motion"

SOURCE: Adapted from Hoover, Korb, et al. Force and Motion. Board of Education, Baltimore Co., 1970.

OBJECTIVE:	To demonstrate qualitatively the concepts of momentum and energy transformation and to design an effective energy absorbing system
TITLE:	"The Car and the Brick Wall"
SOURCE:	Teacher developed from an article by Dean Zollman in The Physics Teacher, March 1975

OBJECTIVE:	To enumerate the characteristics of accelerated motion and uniform motion
TITLE:	"Photographed Motions"
SOURCE:	Teacher developed from Hoover, Korb, et al., Force and Motion. Board of Education, Baltimore Co., 1970

Resources
Grade 9
Physical Science R
Unit: Motion

Text Materials

Abraham, et al. "Analysis of Motion," Introduction to Matter and Energy. 1973, pp. 174-212.

Brandwein, et al. "Laws of Motion," Energy. 1975, pp. 185-210.

Hill and Barcaski. "Motion," Spaceship Earth. 1974, pp. 1-60.

Films -- Grandview Heights Public Library

Action, Reaction, 1967

Filmstrips -- Hastings Library

Experiments With Acceleration, SVE

Newton's Laws of Motion, SVE

Film Loops -- Hastings Library

Analysis of a Hurdle Race

Two-Dimensional Collisions

Transparencies

Teacher collection

Exemplary Activity
Grade 9
Physical Science R
Unit: Motion

OBJECTIVE: To determine the factor or factors that determine the PERIOD of a pendulum. The PERIOD of a pendulum is the time required for a complete vibration, that is, from point 1 to point 5 and back to point 1.

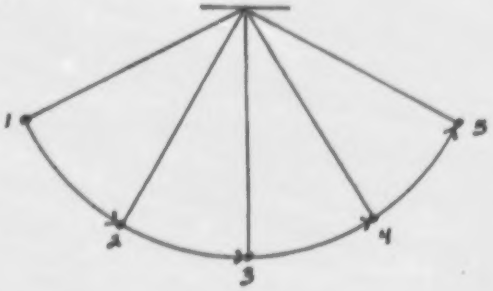
MATERIALS AND EQUIPMENT: See Procedure

Definition: A pendulum is an object mounted so that it can swing back and forth about an axis. Many of you have seen one in a grandfather clock.

Discussion: The ball of the pendulum, when at rest, will be at position 3.

In order to start the pendulum in motion, energy must be used to raise the ball to position 1. The energy that was used to raise the ball is now stored in the ball as potential energy.

When the ball is released, it starts to fall because of the pull of gravity. The stored energy is being changed into the energy of motion -- kinetic energy. The ball speeds up as it falls. When it has fallen exactly halfway, it still has half of its stored energy, but the other half is kinetic energy.



At point 3, the ball has fallen as far as it can and is moving quite fast. All of the stored energy has been turned into the energy of motion.

Now the ball continues to move because of its kinetic energy, but gradually slows down. As it moves higher vertically, energy of motion is being converted again to stored, or potential, energy. Halfway up to the top, the energy is half potential and half kinetic.

When the ball reaches point 5, which is as high as it can go, it stops moving for a small fraction of a second and so has no more kinetic energy. All of its energy is again potential, or stored, energy.

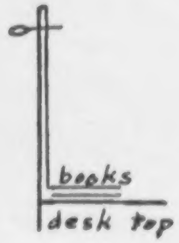
PROCEDURE:

1. Get a large ringstand and attach a ring to it. Place the ringstand on your lab desk so that the ring hangs over the edge of the desk. Use several books to weight down the base of the ringstand.

2. Attach one end of a thread to the ring. Tie a paper clip to the other end and hook a weight through it.

3. Pull the pendulum about 20 cm from its rest position. Release and keep track of the number of seconds that it takes for the pendulum to make 20 complete swings (round trips). Record.

4. Repeat, starting at 3 or 4 other distances from the rest position. Record. Calculate the period of the pendulum by this method: $\text{period} = \frac{\text{time in seconds}}{\text{20 swings}}$



DATA TABLE I: Effect of starting position on period of a pendulum

Trial	Distance from rest position	Time to complete twenty swings	Period (seconds/swing)

INTERPRETATION OF DATA TABLE I:

a. According to your data, what is the period of your pendulum?

b. What seems to be the relationship between the starting position of a pendulum and its period?

c. What would be the period of your pendulum if you released it from its rest position?

5. You have determined the effect of changing the starting position of your pendulum system. Now you are to determine the effect of the weight supported by the pendulum string.

Record the data from Table I for your original weight with a starting position of 20 cm. Use two different weights in addition, one heavier and one lighter than your original weight. Be sure to adjust the length of your string so that the bottom of each system is exactly the same. Record your results in Table II.

DATA TABLE II: Effect of changing the weight of the pendulum bob

Trial	Distance from rest position	Weight of bob	Time for 20 swings	Period (seconds/swing)
1				
2				
3				

INTERPRETATION OF DATA TABLE II:

What is the relationship between a pendulum's weight and its period?

6. The third thing you are to investigate is the relationship between the length of a pendulum and its period. To do this, start with your original pendulum length and weight and 20 cm from rest.

   Using the same weight, find the period for four different lengths of string. Measure length from attachment point to bottom of weight. Record data in table below.

DATA TABLE III: Effect of changing the length of a pendulum

Trial	Length of Pendulum	Distance from rest	Time for 20 swings	Period (seconds/swing)
1				
2				
3				
4				

INTERPRETATION OF DATA TABLE III:

a. Does the length of the pendulum affect the period?

b. What is the effect of shortening the length of the pendulum?

CONCLUSIONS:

1. Which of the three variables that you studied (starting position, weight of bob, and length of pendulum) determines the period of a pendulum?

2. Why does a pendulum eventually come to rest?

Teacher developed

Evaluation Sample
Grade 9
Physical Science R
Unit: Motion

Test: Laws of Motion

Name ______________________________
Period __________ Date ______________

MATCHING: Choices may be used once, more than once, or not at all.

____ 1. Unit of force in the metric system

____ 2. That property of mass that causes it to resist any change in its state of motion

____ 3. Rate at which speed or velocity changes

____ 4. A measure of the force of gravity

____ 5. Forces are ____ quantities because they have both magnitude and direction.

____ 6. Change in position of an object as compared to a reference point

____ 7. Quantity of matter in an object

____ 8. A push or a pull tending to cause motion

____ 9. A car stops suddenly; passengers are thrown forward. Which law?

____10. For every action force there is an equal and opposite reaction force.

A. acceleration
B. First Law of Motion
C. force
D. inertia
E. mass
F. momentum
G. motion
H. Newton
I. Second Law of Motion
J. speed
K. Third Law of Motion
L. vector
M. velocity
O. weight

____11. Objects that have inertia are (a) those at rest (b) those in motion (c) both those at rest and those in motion.

____12. $F = ma$ is a mathematical expression of which law of motion: (a) first (b) second (c) third.

____13. The momentum of a moving body is the product of its mass and its (a) velocity (b) acceleration (c) distance.

____14. $m_1v_1 = m_2v_2$ is the mathematical expression of (a) First Law of Motion (b) Second Law of Motion (c) Third Law of Motion (d) Law of Conservation of Momentum.

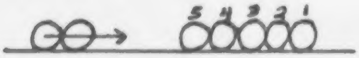
____15. With a fixed force, the acceleration produced on an object as the mass of the object increases will (a) increase (b) decrease (c) remain the same.

____16. With a given mass, increasing the force applied to it will cause the acceleration of the mass to (a) increase (b) decrease (c) remain the same.

____17. Objects move because of (a) balanced forces (b) equal forces (c) unbalanced forces.

____18. When an object is in motion, the force of friction always acts (a) in the same direction as the motion (b) in the opposite direction (c) perpendicular to the motion.

____19. When two steel balls are rolled into five identical steel balls as shown,



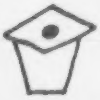
(a) all balls will move slightly to the right
(b) balls 1, 2, 3, 4, 5 will move to the right
(c) balls 1 and 2 will move to the right.

____20. Which of the following is an example of unbalanced forces operating: (a) an object at rest (b) an object moving with constant speed (c) an object accelerating.

____21. A rocket lifting off into space is an example of which law of motion? (a) first (b) second (c) third

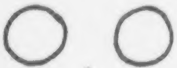
____22. Two people on ice skates face each other. John pushes Bill, but both skaters move away from each other. This is an example of which law of motion? (a) first (b) second (c) third

____23.

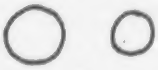


A piece of cardboard is flicked off the glass with a finger; the ball falls into the glass. This is an example of which law of motion? (a) first (b) second (c) third

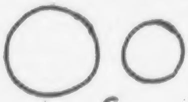
____24. In which of the following cases would the gravitational attraction between two bodies be the greatest?



A

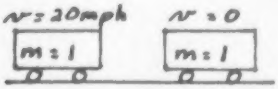


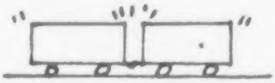
B

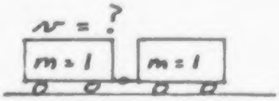


C

____25. According to the Law of Conservation of Momentum, the momentum before a collision is equal to the momentum after a collision. Using this information and the relationship that follows in terms of mass and velocity, what would be the velocity of the two freight trains after they are coupled together?



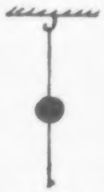




(a) 20 mph (b) 10 mph (c) 15 mph (d) zero mph

Bonus: Study the arrangement of two strings and a heavy weight weight shown. If the string is pulled slowly and steadily, it will break in one place; if jerked suddenly, the string will break in another place.

Explain whether the steady pull or the jerk will cause the string to break below the weight. Give your reason!



Unit Outline
Grade 9
Physical Science R
Unit: Physical Properties of Matter

I. Measurement
    A. Metric system
    B. Mass vs. weight
    C. Graphing
    D. Inverse and direct proportion

II. Energy
    A. Kinetic and potential energy
    B. Conversion and transformation

III. Density
    A. Determination
    B. Application

IV. Liquids
    A. Pressure
    B. Buoyancy

V. Gases
    A. Pressure and volume
    B. Temperature and volume

VI. Solubility
    A. Determination
    B. Application

VII. Thermal Energy
    A. Temperature
    B. Heat including transference
    C. Change of state

Suggested Activities
Grade 9
Physical Science R
Unit: Physical Properties of Matter

OBJECTIVE: To determine density of metal paper clips and, by graphing data, to show constant relationship of mass to volume

TITLE: "Investigation of Density: Paper Clip Laboratory"

SOURCE: Unknown, teacher developed

OBJECTIVE: To study the relationship between the apparent loss of weight of a completely submerged object and the weight of water it displaces

TITLE: "Weight in Air and Weight in Water"

SOURCE: Teacher developed

OBJECTIVE: To investigate adhesion, cohesion, and surface tension of water

TITLE: "Nature of Drops"

SOURCE: Teacher developed

OBJECTIVE: To observe the differences between solutions and suspensions

TITLE: "Solutions and Suspensions"

SOURCE: Modified from exercise in text. Fisk, Franklin G. and Blecha, Milo K. The Physical Sciences. Laidlaw Brothers, 1971.

OBJECTIVE: To use solubility as a method of determining the identity of an unknown substance

TITLE: "Solubility"

SOURCE: Unknown, teacher developed and revised

OBJECTIVE: To observe heat of fusion

TITLE: "Heat of Fusion"

SOURCE: Modified from exercise in text. Bickel, Charles L.; Eigenfeld, Neal D.; and Hogg, John C. Physical Science. D. Van Nostrand Co., 1966.

OBJECTIVE: To determine amount of heat loss or amount of heat gain in water

TITLE: "Heat Loss or Gain"

SOURCE: Unknown, teacher developed

Classroom Demonstrations

- Conduction, Connection, and Radiation
- Determination of Final Temperature in Heat Exchange
- Effect of Low Pressure on Boiling
- Expansion of Gases, Liquids, and Solids

Resources
Grade 9
Physical Science R
Unit: Physical Properties
of Matter

Text Materials

Brandwein, Paul F. Energy, A Physical Science. Harcourt, Brace, Jovanovich, 1975, pp. 4-57, 117-124, 211-226.

Films -- Grandview Heights Public Library

Attraction of Gravity

Buoyancy

How Things Dissolve

Film Loops -- Hastings Library

Air Pressure: Change With Altitude

Density

Mass, Weight, and Volume

Transparencies -- Hastings Library

Heat: Its Measurement, Transfer, and Effects

Exemplary Activity
Grade 9
Physical Science R
Unit: Physical Properties
of Matter

OBJECTIVE: To investigate the nature of drops

MATERIALS AND EQUIPMENT: 1 dropping bottle; 1 piece each: wax paper, aluminum foil, paper toweling; toothpick

PROCEDURE:

1. Using the dropper, put several drops of different sizes on wax paper. Make one as small as possible, the largest as big as possible.
   a. What happens to the shape of the drops as they get bigger?

      ____

   b. Show change in shape with sketches.

   c. Can you think of any explanation for the change in shape?

      ____

2. Place two small drops as close together as possible.
   a. How close must they be before they interact? ________________
   b. Describe what happens when they interact (touch).

      ____

3. Carefully touch a medium-sized droplet with the tip of a clean toothpick.
   a. Can you touch the drop lightly enough to cause a dent in the water?

      ____

   b. What happens when you pull the toothpick away?

      ____

4. Dip the tip of your toothpick into soap solution. Touch the tip to several water drops.
   a. What happens to water drops when touched with soap solution?

      ____

5. Go to demonstration desk. Using a dropper there, drop 3-4 drops of water into a beaker of oil. Do not put dropper into oil.

   a. What happens to the water drops when they reach the oil?

   ____

   b. What is their shape as they sink? ____________________

6. Repeat procedures 1 and 2 using aluminum foil and paper toweling. Record your observations.

   a. Aluminum foil ______________________________________

   ____

   b. Paper toweling ______________________________________

   ____

Interpretation: Refer to Energy, pp. 223-225 or
to Physical Science, Bickel, pp. 103-104.

Define:
1. adhesion
2. cohesion
3. surface tension

How does surface tension explain your observations in today's activity? Be as specific as possible.

Evaluation Sample
Grade 9
Physical Science R
Unit: Physical Properties
of Matter

Chapter I -- Measurement

Section I -- Matching. Use the choices once or not at all.

____ 1. Metric unit of length

____ 2. Substance with definite volume but changeable shape

____ 3. Instrument used to determine mass of an object

____ 4. Metric unit of liquid volume

____ 5. Quantity of matter in an object

A. equal arm of triple beam balance
B. gas
C. graduated cylinder
D. gram
E. flask
F. litre
G. liquid
H. mass
I. metre
J. solid
K. spring balance
L. volume
M. weight

Section II -- Multiple Choice. Select the best answer.

____ 1. Matter will always have (A) weight (B) mass (C) solid form (D) life.

____ 2. A container used to measure the volume of a liquid accurately is a (A) beaker (B) graduated cylinder (C) meniscus (D) milliliter.

____ 3. The metric system is based upon multiples of (A) 1 (B) 10 (C) 100 (D) 1000.

____ 4. When an object is different than it appears to be, it is said to be an optical (A) illusion (B) delusion (C) confusion (D) all of the preceding answers.

____ 5. An object with a mass of one gram (A) may have weight (B) cannot have weight (C) must have weight (D) has no weight.

____ 6. A basic unit in both the British and metric systems of measurement is the (A) metre (B) second (C) pound (D) pint.

____ 7. Gravitational force is measured in terms of (A) length (B) weight (C) distance (D) mass.

____ 8. Since the planet Earth is larger at its equator, your weight at the equator would be (A) greater than at the poles (B) less than at the poles (C) same as at the poles (D) same as it is now.

Evaluation Sample (Cont.)
Grade 9
Physical Science R
Unit: Physical Properties
of Matter

____ 9. A cube with a length of 2 mm on each side has a volume of (A) $2mm^3$ (B) $4mm^3$ (C) $6mm^3$ (D) $8mm^3$.

____ 10. The most dense samples of matter are found (A) among solids (B) in solutions (C) in liquids (D) in gases.

____ 11. A cube of mahogany wood balances a cube of balsa wood on an equal arm balance. The cubes must have the same (A) surface area (B) length (C) volume (D) mass.

____ 12. If there were no forces of gravity acting on an object, the object would have no (A) mass (B) volume (C) weight (D) length.

____ 13. One milliliter is the same as (A) 1 cm (B) 1 cm^2 (C) 1 cm^3 (D) 1,000 liters.

Section III -- Problems

Part A -- Convert the following metric measurements:

1. 325 cm = ________ m

2. 45 mm = ________ cm

3. 1.2 L = ________ ml

4. 687 gm = ________ kg

Part B

5. Find the total of the following in metres:

230 cm + 55 m + 3200 mm + 0.5 km = ________

6. A cardboard carton is 40 cm long, 20 cm wide, and 25 cm deep. What is its volume? (Use the 4-step method.)

____

Section IV -- Increases, Decreases, Remains the Same. Place an I for increases, a D for decreases, or an RTS for remains the same in the blanks on the left.

____ 1. As a person rises rapidly in an elevator, his/her weight will ___.

____ 2. As a solid is changed into a liquid, its mass will ___.

____ 3. The weight of a person coming down a mountain will ___.

Evaluation Sample (Cont.)
Grade 9
Physical Science R
Unit: Physical Properties
of Matter

____ 4. Unless a force acts on an object, its inertia will ___.

Bonus (2 points)

Clearly tell the meanings of weight and mass, using examples.

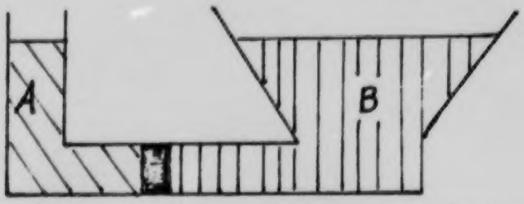
Evaluation Sample (Cont.)
Grade 9
Physical Science R
Unit: Physical Properties
of Matter

Chapter II -- Water

Part A -- Multiple Choice. Select the best answer.

____ 1. In which unit should pressure be expressed? (A) gm/in^2 (B) gm-cm (C) gm/cm^3 (D) gm/cm^2

____ 2. Liquids exert pressure (A) upwards only (B) downwards only (C) both up and down, but not to the side (D) equally in all directions.



____ 3. In the figure above, if the liquid A is mercury and the liquid B is water, when the partition is first removed, the boundary between the liquids will move (A) to the right (B) to the left (C) to mix immediately (D) not at all.

____ 4. The density of water is 62.4 lb/ft^3. Therefore, the pressure at a depth of 10 ft is (A) 624 lb/ft^2 (B) 624 lb/in^2 (C) 624 (D) 624 lb.

Use the following information for question 5:

	Liquid	Density in gm/ml
A.	alcohol	0.79
B.	carbon tetrachloride	1.60
C.	ether	0.71
D.	glycerine	1.26

____ 5. A graduate filled to a height of 15 cm would have the greatest pressure at the bottom if it were filled with: A, B, C, D.

6. IN THE BLANK, PLACE A 'CO' FOR COHESION AND AN 'AD' FOR ADHESION AS DEMONSTRATED BY EACH OF THE FOLLOWING.

____ a. Chalk on the blackboard

____ b. Rain droplets on the window

____ c. Mercury droplets on the floor

____ d. Band-Aid on your finger

____ e. Gum under the desk

____ 7. In order to increase the amount of sugar that will dissolve in a given amount of water, the water should be (A) allowed to evaporate (B) heated (C) permitted to stand overnight (D) cooled.

____ 8. Whenever sugar is dissolved in water, water is the (A) solute (B) saturated solution (C) solvent (D) dilute solution.

____ 9. A mixture of cornstarch and water is an example of a/an (A) alloy (B) pure substance (C) suspension (D) solvent.

____10. When no more of a substance will dissolve in a liquid, the solution is called (A) weak (B) unsaturated (C) saturated (D) dilute.

____11. If a substance will not dissolve in a liquid to form a solution, the substance is a/an (A) filtrate (B) solute (C) solvent (D) insoluble.

____12. When water evaporates from a dilute solution of sugar, the solution finally becomes (A) a tincture (B) more dilute (C) concentrated (D) a suspension.

____13. In order to determine how much of a solid will dissolve in 100 gm of water at a given temperature, it is necessary to consult a table of (A) melting points (B) boiling points (C) solubilities (D) densities.

____14. The mass of a sample of water, measured in grams, is numerically equal to its (A) volume in milliliters (B) volume in liters (C) volume in millimeters (D) all of the above.

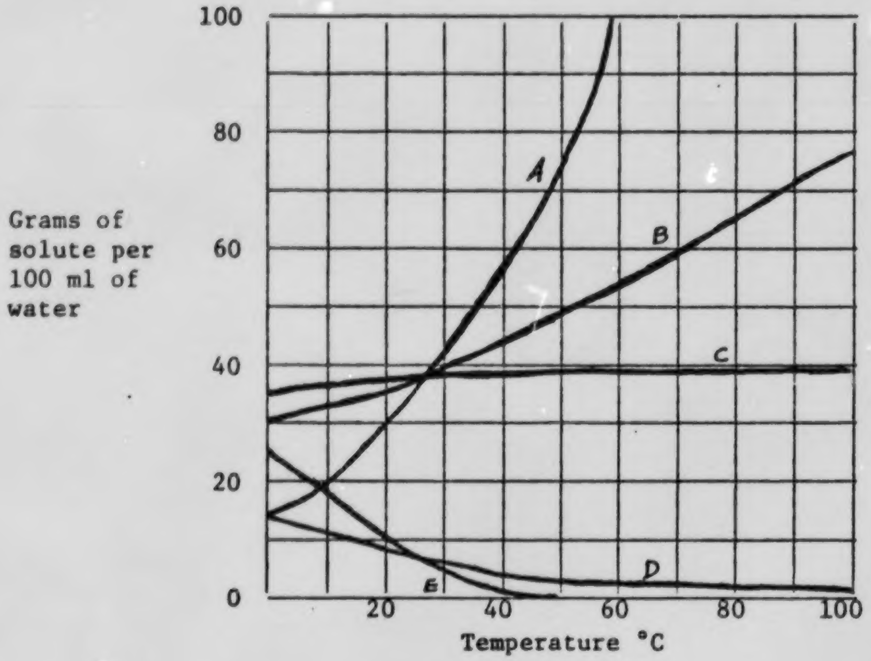
____15. A mixture of solid solutions such as steel is called (A) bimetallic (B) suspension (C) alloy (D) solder.

____16. A pharmacist preparing a tincture uses (A) benzine (B) alcohol (C) carbon tetrachloride (D) water.

Evaluation Sample (Cont.)
Grade 9
Physical Science R
Unit: Physical Properties
of Matter

Part B -- The following questions are based on the graph shown below.

SOLUBILITIES AS A FUNCTION OF TEMPERATURE



____ 1. Two substances that decrease in solubility as the temperature increases are ____(1)____ and ____(2)____.

____ 2.

____ 3. The most soluble compound is ________________.

____-4. At 50°C, the amount of substance B that will dissolve in 50 ml of water is ____________________.

Bonus -- 3 points

How can a chemist prepare a dilute solution that is also a saturated solution? (Note: Refer to above diagram.)

Unit Outline
Grade 9
Physical Science R
Unit: Chemical Properties
of Matter

I. Classification of Matter

- A. Mixtures and their properties
  - 1. Homogeneous -- solutions, alloys
  - 2. Heterogeneous
- B. Substances and their properties
  - 1. Elements
  - 2. Compounds

II. Changes in Matter

- A. Physical change
  - 1. Separating mixtures
  - 2. Identifying substances
    - a. Melting and boiling points
    - b. Flame tests
    - c. Solubility
    - d. Chromatography
- B. Chemical change
  - 1. Reaction rate
  - 2. Synthesis reactions and the properties of oxygen, hydrogen, and carbon dioxide
  - 3. Decomposition reactions and the properties of water
  - 4. Single replacement reactions and the properties of metals
  - 5. Double replacement reactions and the properties of acids and bases

III. Particulate Nature of Matter

- A. Evidence for atoms and molecules
- B. Atomic structure
- C. Periodic Law and the Periodic Table
  - 1. Atomic number
  - 2. Atomic mass
- D. Symbols and formulas
- E. Bonding

IV. Carbon Compounds

- A. Foods and their preservation
- B. Reading labels
- C. Hydrocarbons
- D. Carbohydrates, fats, proteins, alcohols, and acids
- E. Polymers

Suggested Activities
Grade 9
Physical Science R
Unit: Chemical Properties of Matter

OBJECTIVE: To construct a record of observed properties of substances and to enumerate these as chemical or physical

TITLE: "Identifying Substances"

SOURCE: Teacher developed from the Elementary Science Study unit "Mystery Powders"

OBJECTIVE: To identify substances on the basis of physical and/or chemical properties

TITLE: "Flame Tests and Iodine Test"

SOURCE: Teacher developed from Spaceship Earth Physical Science by Hill and Barcaski

OBJECTIVE: To apply differences in a physical property to the separation of a mixture

TITLE: "Paper Chromatography"

SOURCE: Teacher developed from Spaceship Earth Physical Science by Hill and Barcaski

OBJECTIVE: To use a chemical reaction to compare the properties of acids

TITLE: "Titration of Acids"

SOURCE: Teacher developed from A Sourcebook for the Physical Sciences by Joseph et al.

OBJECTIVE: To become familiar with the acid-base properties of common household substances

TITLE: "A Take-Home Lab Using Litmus"

SOURCE: Teacher developed

OBJECTIVE: To demonstrate the differences between mixtures and substances

TITLE: "Pure Substance"

SOURCE: Teacher developed from *Spaceship Earth Physical Science* by Barcaski

OBJECTIVE: To demonstrate some chemical and physical properties of oxygen

TITLE: "Oxygen"

SOURCE: Teacher developed from *Physical Science, A Modern Approach* by Bickel

OBJECTIVE: To demonstrate some chemical and physical properties of hydrogen

TITLE: "Hydrogen"

SOURCE: Teacher developed from *Physical Science, A Modern Approach* by Bickel

OBJECTIVE: To design a method for testing and comparing products that contain ammonia

TITLE: "An Analysis of Products Containing Ammonia"

SOURCE: Teacher developed from *A Sourcebook for the Physical Sciences* by Joseph et al.

OBJECTIVE: To analyze and compare the relative reactivities of selected metals

TITLE: "The Activity of Metals"

SOURCE: Teacher developed

OBJECTIVE: To realize that grouping or classifying is a technique used to simplify the study of complex situations

TITLE: "Making a Periodic Chart"

SOURCE: Interaction of Matter and Energy by Abraham

Text Materials

Abraham, Norman; Balch, Patrick; Chaney, Donald; and Rohrbaugh, Lawrence M. Interaction of Matter and Energy. Rand McNally, 1975, p. 82.

Bolton, Ruth P. Action Chemistry. Holt, Rinehart and Winston, Inc., 1973.

Brandwein, Paul F. Energy, A Physical Science. Harcourt, Brace, Jovanovich, 1975, pp. 60-137.

Carter, Joseph et al. Physical Science. Ginn, 1974.

Hill/Barcaski. Spaceship Earth. Houghton Mifflin, 1974, pp. 247-417.

Joseph et al. A Sourcebook for the Physical Sciences. Harcourt, Brace and World, Inc., 1961.

Films

Aluminum: Metal of Many Faces

Copper, the Oldest Modern Metal

The Extraordinary World of Zinc

The Lead Matrix

"O" is for Oxygen

Wealth Out of Waste

Filmstrips

Acids and Bases -- Jones Library

Catalysts at Work -- Hastings Library

Chemical Reactions -- Jones Library

Periodic System -- Jones and Hastings Libraries

Pamphlets

Food Additives. Manufacturing Chemists Association, 1974.

Exemplary Activity
Grade 9
Physical Science R
Unit: Chemical Properties
of Matter

OBJECTIVE: To construct a record of observed properties of substances and to enumerate these as chemical or physical

MATERIALS AND EQUIPMENT: Cornstarch, talcum powder, baking soda, baking powder, water, white vinegar, iodine solution (diluted to give water a slight orange color), medicine dropper, spoons, large refuse jar

BACKGROUND:

Materials exhibit certain characteristics called properties. Some of these properties, such as weight and particle size, may vary with the amount of the specimen used. Other properties, such as color, odor, taste, luster, behavior in water, reaction to heat, attraction by a magnet, and behavior with acid, are characteristic of the material and may be used to identify the material. Using these properties, one is able to classify and identify many materials.

SPECIAL INSTRUCTIONS:

1. Use clean spoons and medicine droppers to remove substances from stock containers.

2. Remove only about 1/4 teaspoon for the test you are doing.

3. Never return excess materials to stock bottles; put in refuse jar.

4. Put solid materials on small piece of folded paper to transfer to test container.

PROCEDURE: PART I

Take a small amount of each of the four solid substances and examine them. Using only your senses, record your observations in the space below.

PART II

Take a small amount of each of the four solid substances. Test each of them with the three liquids and record your results below. Make sure you try it once with just a few drops of the liquid and once with many drops.

Use the information that you have discovered about each of the solids to describe it in the space below. Make sure you include both physical properties (Part I) and chemical properties (Part II).

What is a physical property?

What is a chemical property?

PART III

Using the data that you organized in Part II, test the unknown solids labeled A, B, C, and D. Do only as many tests as are needed and record your results below.

solid	prediction	test	reaction	conclusion
A				
B				
C				
D				

PART IV

Using the data that you found in Part III, identify the liquids labeled X, Y, and Z. Food coloring has been added to make them all appear the same color.

WHEN YOU ARE SATISFIED WITH ALL OF YOUR RESULTS, ANSWER THE FOLLOWING QUESTIONS.

1. You should know what each of the following words means:

    property --

    physical property --

chemical property --

effervescent --

stock bottle --

refuse jar --

2. If I give you one of the four white solids but do not tell you which one, and you find it does not turn blue-black when tested with a few drops of iodine solution, can you be certain whether it contains cornstarch?

   Can you be certain that the unknown substance contains talcum powder? Why or why not?

3. Which of the four substances might it be if it produced bubbles when treated with vinegar?

   How could you find out by doing just one more test?

4. What is released when the solution effervesces (bubbles)? Why does it stop after a while?

5. Suppose that an unknown white powder became light tan when it was tested with iodine solution. Which substance could you be certain that it was not?

6. What are the advantages of your method of data taking in Part II?

   What are the disadvantages?

Evaluation Sample
Grade 9
Physical Science R
Unit: Chemical Properties
of Matter

CHEMISTRY TEST

Section I. Multiple Choice -- Choose the one best answer.

____ 1. That branch of chemistry termed organic deals with compounds that contain (A) hydrogen (B) carbon (C) oxygen (D) sodium.

____ 2. From the name you can tell that carbohydrates contain (A) nitrogen and water (B) carbon and hydroxide (C) nitrogen and hydroxide (D) carbon and water.

____ 3. Manganese dioxide can speed up the decomposition of potassium chlorate into potassium chloride and oxygen. It is therefore called (A) an enzyme (B) a catalyst (C) an indicator (D) all of these.

____ 4. Which of the following must occur before the reaction is termed combustion? (A) light is given off (B) heat is given off (C) oxidation is occurring (D) all of the above

____ 5. You are testing an unknown powder to determine what it is. You are told that it is safe to taste and you learn that it tastes bitter. One inference is that the powder is (A) an oxide (B) a base (C) an acid (D) none of these.

____ 6. Which of the following would you use to follow up your taste test in number 5 above? (A) neutral litmus paper (B) a bunsen burner flame (C) a flame test loop (D) all of the above

____ 7. Which of the following is flammable? (A) oxygen (B) methane (C) nitrogen (D) helium

____ 8. You are given a material and told that it is a compound. Which of the following might you use to separate it into its component parts? (A) filtration (B) chromatography (C) solution (D) none of these

____ 9. An organic substance present in your saliva helps in the breakdown of starch to sugar. This substance can therefore best be termed (A) an enzyme (B) a catalyst (C) an indicator (D) all of these.

____ 10. Sometimes an additive allowed by the Food and Drug Administration has questionable safety ratings. An additional consideration is (A) its profit potential for the chemical industry (B) its taste (C) its value in the mass distribution of food (D) none of these, safety is the only consideration.

Evaluation Sample (Cont.)
Grade 9
Physical Science R
Unit: Chemical Properties
of Matter

____11. Phenolphthalein is added to a substance. The phenolphthalein is colorless in the substance. Which of the following properties would you attribute to the substance? (A) sour taste (B) ability to support combustion (C) ability to neutralize an acid (D) giving off a crimson color in a flame test

____12. You spill concentrated sulfuric acid on the floor. Your best course of action would be to (A) add water quickly (B) throw paper towels on the spill (C) throw a weak base on the spill (D) run screaming from the room.

____13. You are given a material and told that it is a mixture. Which of the following might you use to separate it into its component parts? (A) filtration (B) electrolysis (C) heat it (D) none of these

____14. Which of the following observations would support an inference that a chemical change occurred when a blue substance is added to water? (A) the substance disappears (B) the water changes color (C) violent bubbling begins (D) all of the above

____15. A glowing splint is thrust into a bottle containing a gas. If the splint bursts into flame, the gas in the bottle is (A) hydrogen (B) steam (C) oxygen (D) carbon monoxide.

____16. Oxidation in which heat and light are given off is called (A) corrosion (B) combustion (C) rusting (D) both A and B.

____17. A lab technique that depends on the principle of solubility is (A) chromatography (B) filtration (C) iodine test (D) both A and B.

____18. A burning splint is held near the mouth of a bottle containing a gas. If there is a loud "pop," the bas in the bottle was (A) hydrogen (B) steam (C) oxygen (D) carbon dioxide.

____19. A particle that is found in the nucleus of an atom is (A) a proton (B) an electron (C) a neutron (D) both A and C.

____20. The number of protons in the nucleus of an atom is the same as (A) the atomic weight of the atom (B) the number of neutrons in the nucleus (C) the number of electrons outside the nucleus (D) the number of electrically charged particles in the atom.

____21. One of the elements present in cane sugar is (A) sodium (B) water (C) helium (D) carbon.

____22. If you said that an element is a yellow solid at room temperature, you would be (A) describing its physical properties (B) making a quantitative observation (C) reasoning inductively (D) making an inference.

____23. Filtration is used to separate (A) a mixture of liquids (B) a liquid from an undissolved solid (C) a mixture of solids (D) a solution from its dissolved solid.

____24. A substance that changes color in the presence of an acid or base is termed (A) salt (B) indicator (C) solvent (D) none of these.

____25. Which of the following household items is an acid? (A) dish soap (B) Drano (C) lemon juice (D) both A and B

____26. If the atomic weight of an element is 23 and its atomic number is 11, an atom of this element contains (A) 11 protons (B) 11 electrons in the outermost orbit (C) 23 neutrons in the nucleus (D) 23 electrons outside the nucleus.

____27. Which of the following sub-atomic particles has a positive charge? (A) electron (B) neutron (C) proton (D) all of the above.

____28. An atom is electrically neutral because (A) electrons equal neutrons (B) protons equal electrons (C) neutrons equal protons (D) protons are always twice the number of electrons.

____29. An atom has 8 protons and 8 neutrons. Its atomic weight is (A) 8 (B) 64 (C) 0 (D) 16.

____30. A particle that has no charge is the (A) electron (B) proton (C) neutron (D) none of the above.

____31. The "genie" of atomic energy is liberated from (A) sodium (B) magnesium (C) uranium (D) potassium.

____32. The man responsible for reviving the idea of the atom was (A) Aristotle (B) Hooke (C) Socrates (D) Dalton.

____33. By observing dust particles in a drop of water, man got the idea that (A) molecules are in motion (B) molecules have a definite structure (C) molecules are made up of atoms (D) all of the above.

____34. An atom is made up mostly of (A) electrons (B) protons (C) neutrons (D) empty space.

Evaluation Sample (Cont.)
Grade 9
Physical Science R
Unit: Chemical Properties
of Matter

____35. Rutherford discovered (A) atoms (B) electrons (C) molecules (D) the nucleus.

____36. An organic compound made only of hydrogen and carbon is termed (A) carbohydrate (B) hydrocarbon (C) enzyme (D) protein.

____37. A formula that shows how atoms are connected together in a compound is called (A) structural (B) molecular (C) empirical (D) ionic.

____38. Giant molecules made of many smaller molecules connected together are called (A) disaccharides (B) polymers (C) carbohydrates (D) hydrocarbons.

Unit Outline
Grade 9
Physical Science R
Unit: Nuclear Energy

I. Radiation
    A. Review structure of the atom
    B. Isotopes
    C. Radioactivity
        1. Radioactive isotopes
        2. Alpha, beta, gamma rays
        3. Half-life
    D. Radiation detection and measurement
        1. Cloud and bubble chambers
        2. Emulsions
        3. Geiger counter
        4. Roentgen

II. Nuclear Reactions
    A. Nuclear fission
    B. Nuclear reactors
    C. Nuclear fusion
    D. Radioactivity and health

Suggested Activities
Grade 9
Physical Science R
Unit: Nuclear Energy

OBJECTIVE: To illustrate the emission of gamma rays by radium

TITLE: "'Photograph' Your Radium Watch Dial"

SOURCE: Joseph, et al. A Sourcebook for the Physical Sciences. Harcourt, Brace, and World, Inc., 1961, p. 573.

OBJECTIVE: To compare the radioactivity of uranium salts, radioactive isotopes, and a radium watch dial

TITLE: "Using a Geiger Counter"

SOURCE: Joseph, et al. A Sourcebook for the Physical Sciences. Harcourt, Brace, and World, Inc., 1961.

OBJECTIVE: To construct a cloud chamber and detect the emissions of radioactive thorium

TITLE: "Using a Cloud Chamber"

SOURCE: Williams, George A., et al. Challenges to Science: Physical Science. McGraw-Hill Book Co., 1973, p. 379.

OBJECTIVE: To develop a model of radioactive decay, use the model to generate data for a decay curve, and apply the half-life of carbon-14 in predicting the age of a given sample

TITLE: "Laboratory: Half-Life"

SOURCE: Ramsey, et al. Physical Science. Holt, Rinehart, and Winston, 1978, p. 441.

OBJECTIVE: To illustrate controlled and uncontrolled chain reactions

TITLE: "Domino Models of Chain Reactions"

SOURCE: Teacher developed from Physical Science by Ramsey, et al.

Resources
Grade 9
Physical Science R
Unit: Nuclear Energy

Text Materials

Brandwein, Paul F., et al. Energy. Harcourt, Brace, Jovanovich, 1975, pp. 138-159.

Ramsey, William L., et al. Physical Science. Holt, Rinehart, and Winston, 1978.

Williams, George A., et al. Challenges to Science: Physical Science. McGraw-Hill Book Co., 1973.

Films

Atomic Energy: Inside the Atom -- Columbus Public Library

Atomic Radiation -- Columbus Public Library

The Atom: Underground -- Indiana University

Learning About Nuclear Energy -- Grandview Heights Public Library

Our Friend the Atom -- Grandview Heights Public Library

Radioactivity -- Indiana University

Radioisotopes: Tools of Discovery -- Indiana University

U^{238} Radioactive Series -- Columbus Public Library

Filmstrips -- Hastings Junior High School

Atomic Detectives

Making Atomic Energy Help Mankind

Putting Atomic Energy to Work

Pamphlets

Fowler, John M. "Factsheet #12, Conventional Reactors," National Science Teachers Association and Energy Research and Development Administration, P.O. Box 62, Oak Ridge, TN 37830.

Pamphlets (Cont.)

Fowler, John M. "Factsheet #13, Breeder Reactors," National Science Teachers Association and Energy Research and Development Administration, P.O. Box 62, Oak Ridge, TN 37830.

Fowler, John M. "Factsheet #14, Nuclear Fusion," National Science Teachers Association and Energy Research and Development Administration, P.O. Box 62, Oak Ridge, TN 37830.

Exemplary Activity
Grade 9
Physical Science R
Unit: Nuclear Energy

Reference:

Ramsey, et al. "Laboratory: Half-Life," Physical Science. Holt, Rinehart, and Winston, 1978, p. 441.

Evaluation Sample
Grade 9
Physical Science R
Unit: Nuclear Energy

Reference:

"The Nucleus," Chapter 15, Test Masters for Holt Physical Science. Holt, Rinehart, and Winston, 1978.

Unit Outline
Grade 9
Physical Science R
Unit: Mechanics

I. Force, Work, Energy

   A. Definitions and relationships
   B. "Perpetual" motion and conservation of energy

II. Simple Machines

   A. Levers with definition of MA
   B. Wheel and axle and gear systems
   C. Gains and sacrifices with all simple machines
   D. Efficiency
   E. Inclined plane
   F. Pulleys

III. Forces in Fluids

   A. Kinetic theory of matter
   B. Pressure definition and alternate formula
   C. Buoyant force and Archimedes' Principle
   D. Adhesion, cohesion, surface tension, capillary action
   E. Barometers and practical applications of air pressure

Suggested Activities
Grade 9
Physical Science R
Unit: Mechanics

OBJECTIVE: To identify a first-class lever and explain its applications in terms of effort, resistance, and direction

TITLE: "The First-Class Lever"

SOURCE: Teacher developed from Physical Science, a Modern Approach by Bickel et al

OBJECTIVE: To analyze the use of the inclined plane by determining the mechanical advantage

TITLE: "The Inclined Plane"

SOURCE: Teacher developed by Joe Caruso

OBJECTIVE: To analyze the advantages of various pulley systems

TITLE: "Pulleys"

SOURCE: Teacher developed by Joe Caruso

OBJECTIVE: To use appropriate units to solve problems related to the pressure exerted by liquids

TITLE: "Pressure of Liquids"

SOURCE: Teacher developed by Fran McCullough, modified by Joe Caruso

OBJECTIVE: To use appropriate units to solve problems related to the pressure exerted by regular solids

TITLE: "Pressure of Solids"

SOURCE: Teacher developed by Fran McCullough

Text Materials

Brandwein, Paul. Energy, A Physical Science. Harcourt, Brace, Jovanovich, 1975, pp. 161-165, 170-181, 124-128, 211-232.

Hill and Barcaski. Spaceship Earth, Physical Science. Houghton Mifflin Co., 1974, pp. 1-19, 61-66, 96-107.

Films

Force of Gravity. Franklin County Media Center

Frames of Reference. Franklin County Media Center

Frontiers of Friction. Shell Oil Company

Laws of Motion. Franklin County Media Center

Exemplary Activity
Grade 9
Physical Science R
Unit: Mechanics

OBJECTIVE: To be able to account for all of the observations of this activity in terms of high and low pressure; and to name at least two devices, processes, or things that require the use of air pressure

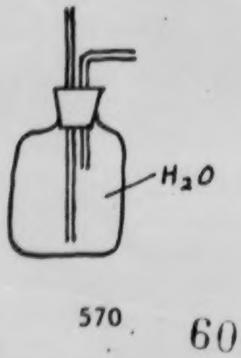
MATERIALS AND EQUIPMENT: Bottle, 2-hole stopper to fit bottle, 30 cm straight glass tube, 90° glass bend, H_2O to fill bottle about half

PROCEDURE:

In this activity you will be working with very simple materials, but the processes you will observe have many applications in everyday life. In answering the "how do you account" questions, think very carefully. Answer these questions by referring to high and low pressure areas. DO NOT WRITE ON THIS PAPER.

1. Make a list of the apparatus used in this activity.
2. What do you observe when you place your mouth over the right angle tube and inhale?
3. How do you account for your observation in #2? Be specific.
4. What do you observe when you blow (but not too hard) into the right angle tube?
5. How do you account for your observation in #4? Be specific.
6. What do you observe when you blow fairly hard into the straight tube while holding your finger over the right angle tube to seal it?
7. How do you account for what you observed while blowing in #6?
8. What happened when you stopped blowing in #6?
9. How do you account for your observation in #8? Be specific.
10. What do you observe when you break the seal at the right angle tube by removing your finger?
11. How do you account for your observation in #10? Be specific.

Apparatus Diagram



SOURCE: Teacher developed from Physical Science, A Modern Approach by Bickel et al.

Evaluation Sample
Grade 9
Physical Science R
Unit: Mechanics

Choose the best answer and use capital letters.

____ 1. Which of the following statements about a moving object is true? It will (A) come to rest without any force acting on it (B) steadily slow down without any force acting on it, but it will not come to rest (C) never slow down (D) never come to rest unless a force opposite to its direction of motion is exerted on it.

____ 2. What must be done to a moving object to make it turn a corner? (A) Nothing, it will turn under the appropriate conditions. (B) Exert a force on it in the direction it is moving. (C) Exert a force on it opposite to the direction it is moving. (D) Exert a force on it in the direction you wish it to turn.

____ 3. On which of the following surfaces will a ball roll with the least friction? (A) Newspaper (B) Glass (C) Carpet (D) Sand

____ 4. To make any object begin to move, (A) a force must be exerted on the object (B) the object must be round (C) under certain circumstances a force is required (D) there are no situations in which a force is required.

____ 5. If two identical balls are given identical pushes across different surfaces, which of the following statements is true? (A) The balls will always go equal distances. (B) The surface with less friction will allow the ball to go farther. (C) The surface with more friction will allow the ball to go farther. (D) The friction has no effect on how far the balls go.

____ 6. The law of conservation of energy tells us that (A) we should all do whatever we can to reduce our energy use (B) energy can be changed from one form to another (C) without conservation, all the energy in the universe will eventually be destroyed (D) by conserving, we can actually increase the total amount of energy in the universe.

____ 7. Kinetic energy is energy of (A) position (B) condition (C) motion (D) either A or B.

____ 8. As a pendulum swings, it has (A) a steady loss of energy due to friction (B) maximum potential energy at the low point of its swing (C) maximum kinetic energy at the high point of its swing (D) all of the above.

____ 9. Two cars move down a highway at exactly the same speed. Which of the following statements is true? (A) They both have the same energy since their speed is the same. (B) The car with greater mass has less energy. (C) The car with greater mass has more energy. (D) Their energy does not depend on speed.

Evaluation Sample (Cont.)
Grade 9
Physical Science R
Unit: Mechanics

____10. As a brick falls from the top of a building, the brick (A) loses kinetic energy (B) loses potential energy (C) gains potential energy (D) both A and C.

____11. In using levers, the force exerted by you is the (A) effort (B) resistance (C) fulcrum (D) leverage.

____12. In the diagram on the side board, where must the fulcrum go to make it a first class lever? (R is the resistance and E is the effort.)

____13. If you push up on one end of a first class lever, in what direction will the other end go? (A) Up (B) Down (C) Sideways (D) Impossible to tell

____14. In the diagram on the side board, the resistance is at #4 and the fulcrum is at #3. The lever requiring the least effort would have the effort applied at (A) #1 (B) #2 (C) #3 (D) #5.

____15. To use a first class lever with the least effort, the fulcrum should be (A) close to the effort (B) at the end of the lever (C) close to the resistance (D) far from the resistance.

____16. A smooth, flat inclined plane is used to raise a 400 lb piano. To push the piano up the plane requires a force (A) greater than 400 lb (B) equal to 400 lb (C) less than 400 lb (D) either A or B.

____17. The main reason for using an inclined plane is that it (A) gives a force advantage (B) shortens the distance for your effort (C) decreases the amount of work you must do (D) both B and C.

____18. In using an inclined plane, (A) work is done against friction (B) no work is done against friction (C) no work is done against gravity (D) less work is required than without the inclined plane.

____19. Two inclined planes are exactly the same length, but one gives a smaller mechanical advantage. This is (A) impossible under any circumstances (B) possible if one is steeper than the other (C) impossible if one is steeper than the other (D) unlikely if one is steeper than the other.

____20. How does work done in moving a body up an inclined plane to a certain height compare to work done in moving the same body vertically (straight up) to the same height? (A) Work up the plane is greater than vertical work, (B) Work up the plane is less than vertical work. (C) Work up the plane is equal to vertical work. (D) A, B, or C, depending on the situation

____21. A single movable pulley gives an MA of approximately (A) 1/2 (B) 1 (C) 2 (D) 4.

____22. The MA of a certain pulley system is 4. If you exert your effort over a distance of 20 cm, you would expect the resistance to move (A) 20 cm (B) more than 20 cm (C) less than 20 cm (D) impossible to tell.

____23. In using a single movable pulley, you would find that your effort is approximately (A) 1/2 the resistance (B) equal to the resistance (C) twice the resistance (D) four times the resistance.

____24. The chief value of a fixed pulley is that it (A) multiplies your force (B) decreases your effort distance (C) changes the direction of your force (D) saves you work.

____25. The pulley system on the side board has an MA of approximately (A) 2 (B) 3 (C) 4 (D) 5.

____26. Four test tubes are filled to the same depth with four different liquids. Which liquid will exert the greatest pressure on the test tube bottom? (A) Acetone (B) Kerosene (C) Benzene (D) Octane

____27. The kinetic theory of matter says that (A) particles of matter are constantly in motion (B) kinetic energy in matter steadily decreases (C) kinetic energy in matter steadily increases (D) matter has no kinetic energy at ordinary temperatures.

____28. Would pressure be greater at a depth of 7 cm in water or at a depth of 10 cm in octane? (A) Greater in water (B) Greater in octane (C) Same in both cases (D) Impossible to tell from the information given

____29. Pressure is (A) force per unit area (B) force per unit volume (C) mass divided by volume (D) force times area.

____30. A tank contains 1210 lb of water. What is the pressure on the bottom of the tank if the bottom area is 11 ft^2? (A) 110 lbs/ft^2 (B) 13,310 lbs (C) 1210 lbs/ft^2 (D) 12.1 lbs/ft^2

____31. Buoyant force (A) is a downward force on an object in a fluid (B) occurs only in liquids (C) occurs only in gases (D) is caused by a difference in pressure on the top and bottom of an object in a fluid.

____32. When you dip your finger into water, your finger gets wet. This is due to (A) adhesion (B) cohesion (C) surface tension (D) Archimedes' Principle.

____33. When an object floats, the buoyant force is (A) greater than the object's weight (B) equal to the object's weight (C) less than the object's weight (D) less than the weight of the fluid displaced.

____34. The rising of liquids in very narrow tubes or cracks is caused by (A) Pascal's Law (B) capillary action (C) Archimedes' Principle (D) buoyant force.

____35. A steel needle can sit on the surface of water because of (A) adhesion (B) Archimedes' Principle (C) capillary action (D) surface tension.

____36. Dirt is taken into a vacuum cleaner because (A) low pressure inside lets high pressure outside push the dirt in (B) low pressure inside pulls the dirt in (C) low pressure inside sucks the dirt in (D) both B and C.

____37. If you put your mouth over the tube at Y and inhale, (A) bubbles will form in the water (B) water in the straight tube will rise (C) a stream of water will shoot out at X (D) both B and C.

____38. What causes your observation in #37? (A) Suction in the bottle pulls air down the straight tube. (B) Pressure down the straight tube and in the bottle are equal. (C) Pressure in the bottle is greater than pressure down the straight tube. (D) Pressure down the straight tube is greater than pressure in the bottle.

____39. If you put your mouth over the tube at X and blow, (A) air will rush in at Y (B) water will rise in the straight tube (C) water will remain level in the straight tube (D) air will rush out at Y.

____40. Your observation in #39 can be explained in the following way. (A) Suction in the bottle pulls air into the bottle at Y. (B) Pressure down the straight tube increases air pressure in the bottle. (C) High pressure in the bottle forces water up the straight tube. (D) Pressure at X equals the pressure in the bottle.

Unit Outline
Grade 9
Physical Science S
Unit: Radiant Energy

I. Wave Motion

   A. Kinds
   B. Water waves
   C. The wave equation

II. The Electromagnetic Spectrum

   A. Total range
   B. Major categories and their effects

III. Visible Light

   A. Dual nature
   B. Transmission and/or absorption
   C. Reflection
   D. Refraction
   E. Optical instruments

IV. Vision

   A. Structure and function of the human eye
   B. Common eye problems and their correction
   C. Perception as a function of eye and mind
   D. Color
      1. Additive primaries
      2. Subtractive primaries

V. New Developments

   A. Lasers
   B. Holography

OBJECTIVE: To verify the principles of reflection

TITLE: "Images in a Plane Mirror"

SOURCE: Developed jointly with F. McCullough

OBJECTIVE: To investigate more thoroughly the characteristics of images formed by plane mirrors

TITLE: "An Investigation of Multiple Images"

SOURCE: Developed by G. Sweitzer from an article in The Science Teacher, February 1973.

OBJECTIVE: To observe the change in direction of a light ray as it passes from one medium to another of different density

TITLE: "The Refraction of Light Through Water"

SOURCE: Teacher developed

OBJECTIVE: To observe how a change in object position affects the size and location of the image formed by a convex lens

TITLE: "An Investigation of Image Formation by Convex Lenses"

SOURCE: Teacher adapted from a variety of textbooks; revised with use

OBJECTIVE: To demonstrate that perception involves interaction of eye and brain, and to identify some factors that determine how an individual will perceive a given object

TITLE: "Now You See It, Now You Don't"

SOURCE: Developed by G. Sweitzer from an article in Scientific American, December 1971 -- "Multistability in Perception."

OBJECTIVE: To demonstrate that the color of an object depends upon its selective absorption of certain colors and reflection of others and also upon what particular wavelengths of light are reaching its surface

TITLE: "An Investigation of Color"

SOURCE: Developed by former staff member

Resources
Grade 9
Physical Science S
Unit: Radiant Energy

Text Materials

Brandwein, P.F. *Energy, A Physical Science*. Harcourt, Brace, 1975.

Fisk, F.G., and Blecha, M.K. *The Physical Sciences*. Laidlaw Brothers, 1971.

Films

The Laser Beam, Grandview Heights Public Library

The Light Fantastic, videotape, Hastings Library

The Unseen World -- Things Too Small, Grandview Heights Public Library

Film Loops

Pulses, Hastings Library

Tacoma Narrows Bridge, 9 science department

Filmstrips -- Hastings Library

Geometrical Optics, Popular Science 10-35

Masers and Lasers, Popular Science 10-37

Transparencies

Optical Illusions, Hastings Library

Reflection and Refraction of Light, Hastings Library

Miscellaneous -- teacher collection

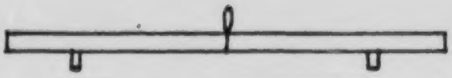
Exemplary Activity
Grade 9
Physical Science S
Unit: Radiant Energy

OBJECTIVE: To investigate the nature, location, and size of images formed when light from an object passes through a convex lens

MATERIALS AND EQUIPMENT: Optical bench, lens, cardboard screen, holders, candle

PROCEDURE:

1. Set up optical bench as shown:



2. With lens at 50 cm mark and candle at 58 cm mark, move the screen back and forth as far as possible. Do you observe a picture of the candle flame? ______ What do you see? ____

3. Keep lens at 50 cm. Gradually move candle away from lens. At each small change in position of the candle, move the screen back and forth to see if an image can be found. Stop moving the candle when at some point you finally get an image of the flame on your cardboard screen. Record results:
   a. distance of candle from lens ____________________
   b. distance of screen from lens ____________________
   c. is image inverted? ______________
   d. approximate size of image ______________

4. Keep lens at 50 cm. Move candle to approximately 75 cm mark. Adjust gradually the distances of candle and screen until you obtain an image on the screen that is sharp and is the same size as the candle flame. Record results:
   a. distance of candle from lens ___________
   b. distance of screen from lens ___________
   c. is image inverted? __________
   d. size of image ______________________

5. Keep lens at 50 cm. Move candle to extreme end of optical bench. Now move screen until the sharpest possible image appears. Record results:
   a. distance of candle from lens __________
   b. distance of screen from lens __________
   c. is image inverted? __________
   d. size of image ___________

6. Leave candle at end of optical bench. Move lens to 25 cm mark. Locate image on screen by moving screen. Record results:
   a. distance of candle from lens ____________
   b. distance of screen from lens ____________
   c. is image inverted? __________
   d. size of image ______________________

CONCLUSIONS:

1. What is the minimum distance the candle must be from the lens in order to form an image on the screen? ____________________________

2. When the candle is two times the focal length away from the lens, the image is the same size as the flame. What is the focal length of your lens? ___________________

3. Are the images formed real or virtual? _________________
How do you know? ____

4. As the candle is moved farther away from the lens, does the image location move closer to or farther from the lens? ____________________________

5. As the candle is moved farther away from the lens, what happens to the size of the image? ____

Evaluation Sample
Grade 9
Physical Science S
Unit: Radiant Energy

PSS TEST: LIGHT, REFLECTION, REFRACTION

Name ____________________________
Period _____ Date ____________

____ 1. A material that allows some, but not all, of the light hitting it to pass through is (a) transparent (b) translucent (c) opaque.

____ 2. The brightness of a source of light is measured in (a) lumens (b) footcandles (c) candlepower (d) decibels.

____ 3. All mirrors work on the principle that the angle of reflection is (a) equal to the focal length (b) equal to the center of curvature (c) equal to the angle of incidence (d) the same as the focal point.

____ 4. The reflection of light from a rough surface is called (a) diffuse reflection (b) regular reflection (c) suffused refraction (d) effusive reflection.

____ 5. The type of mirror that causes reflected rays to cross each other (come to a focus) is (a) plane (b) convex (c) concave.

____ 6. Which of the above is used for store surveillance?

____ 7. Which of the above is used to produce a parallel beam of light as in flashlights or car headlights?

____ 8. If 800 footcandles of light are falling on a surface one foot from a light source, what would a lightmeter read two feet from the source? (a) 800 footcandles (b) 400 footcandles (c) 200 footcandles (d) 100 footcandles

____ 9. An image that cannot be projected on a screen is called (a) real (b) virtual (c) virtuous (d) unreal.

____ 10. One cannot see through a bent metal pipe because (a) lenses bend rays of light (b) the pipe casts shadows (c) light travels in straight lines (d) the eye is similar to a camera.

____ 11. A ray of light that strikes a surface is called a/an (a) incident ray (b) reflective ray (c) emergent ray (d) insidious ray.

____ 12. The change of direction of light rays as they pass into a medium of different density is called (a) infraction (b) diffraction (c) dispersion (d) refraction.

____ 13. A beam of parallel rays strikes a plane mirror. They will be reflected as (a) parallel rays (b) diverging rays (c) converging rays (d) scattered rays.

____14. When light passes from a less dense material into a more dense material, as air to water, the rays are bent (a) away from the normal (b) toward the normal (c) only if they strike on the perpendicular (d) in a curved path.

____15. The point at which light rays come together after passing through a converging lens is called the (a) optical center (b) center of curvature (c) focal point (d) principal axis.

____16. A ray of light traveling through air and striking a piece of glass will (a) increase in speed (b) decrease in speed (c) remain at the same speed (d) be totally reflected.

____17. An image is real if (a) you can see it (b) it is right side up (c) it is formed by a plane mirror (d) it is formed on a screen.

____18. The light-gathering part of a reflecting telescope is a (a) concave mirror (b) convex mirror (c) concave lens (d) convex lens.

____19. The only light rays passing through a lens that are not refracted but continue straight are those (a) parallel to the principal axis (b) passing through the focal point (c) passing through the optical center (d) from the bottom of the object.

____20. As the density of a substance through which light passes increases, the speed of light (a) increases (b) decreases (c) remains the same.

____21. As you move an object (such as a candle) farther from a convex lens, the size of the image formed on a screen (a) increases (b) decreases (c) remains the same.

____22. The incident ray of light strikes a mirror at an angle of 45° to the normal. The angle between the incident ray and the reflected ray will be (a) 22.5° (b) 45° (c) 90° (d) 112.5°.

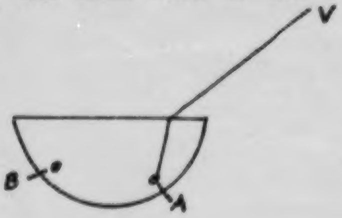
____23. The ratio of the velocity of light in a vacuum to the velocity of light in another medium is known as the index of (a) transmission (b) diffusion (c) reflection (d) refraction.

____24. When a lighted bulb is placed at the focal point of a converging or parabolic mirror, the rays striking the mirror are (a) reflected and converge at the center of curvature (b) refracted (c) reflected as parallel rays (d) reflected as diverging rays.

____25. As you read this question, (a) light is reflected from the paper to your eyes (b) light is reflected from your eyes to the paper (c) the paper is a luminous body (d) light from your eyes illuminates the paper.

____26. A real image formed by a convex lens is (a) always larger than the object (b) always the same size as the object (c) always smaller than the object (d) either larger, smaller, or the same size as the object.

____27. The sketch shows a penny at point A in a small dish of water. A viewer at point V would (a) see the penny at A (b) see the penny at B (c) not see the penny at all.



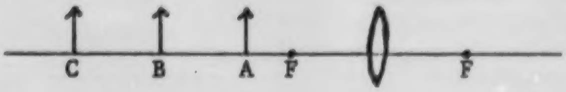
____28. A concave lens can (a) produce only real images (b) produce only virtual images (c) produce either real or virtual images.

____29. Light travels as (a) a transverse wave (b) a stream of particles (c) both a transverse wave and a stream of particles (d) a longitudinal wave.

____30. A glowing light bulb is an example of light that is (a) fluorescent (b) incandescent (c) illuminescent (d) none of the foregoing.

____31. The line drawn perpendicular to the point where a ray of light strikes a surface is called the (a) reference line (b) normal line (c) reflection line (d) angular line.

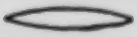
32 and 33 refer to this sketch:

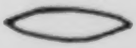


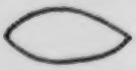
____32. An image will be formed closest to the lens when the object is at position (a) A (b) B (c) C.

____33. The image formed will be largest when the object is at (a) A (b) B (c) C.

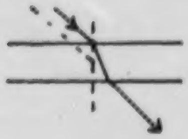
____34. Which of the lenses shown would have the shortest focal length?

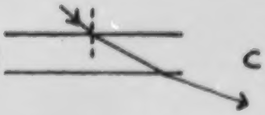
A 

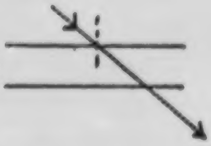
B 

C 

____35. Which of the 3 sketches correctly shows the path light takes through a pane of glass?

A 

B 

C 

____36. When electrons that have gained extra energy then fall back to their original levels, they give off tiny bundles of light energy known as (a) lumens (b) candelas (c) photons (d) photicles.

____37. Convex lenses are (a) thin in the middle, thick at the edges (b) thin in the middle, thin at the edges (c) thick in the middle, thin at the edges (d) thick in the middle, thick at the edges.

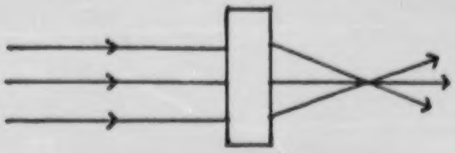
____38. The focal length of a lens is measured from the center of the lens to the (a) normal (b) focal point (c) object (d) source of light.

____39. A simple astronomical telescope contains (a) 2 concave lenses (b) 1 concave and 1 convex lens (c) 2 convex lenses (d) 3 concave-convex lenses.

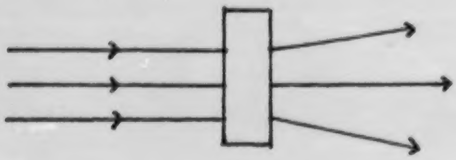
____40. Light rays travel fastest in (a) air (b) water (c) glass.

Draw the type of lens that would produce the results shown:

a.

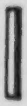


b.

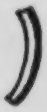


Name each of the following as to lens or mirror, and type of each:

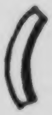
a.



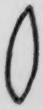
b.



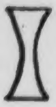
c.



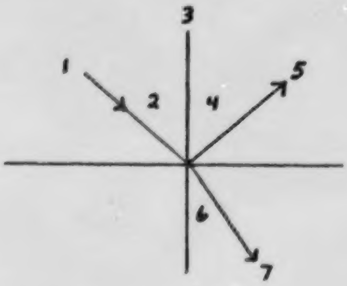
d.

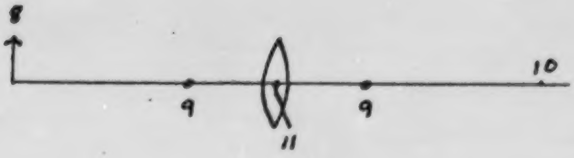


e.



Name the numbered parts in the following sketches:





1.____________________

2.____________________

3.____________________

4.____________________

5.____________________

6.____________________

7.____________________

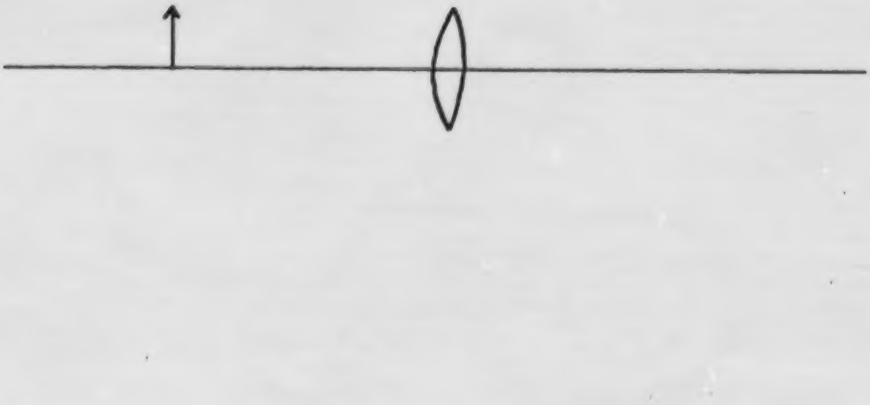
8.____________________

9.____________________

10.____________________

11.____________________

Complete the following diagram by constructing two rays from the tip of the arrow. Show image location.



Unit Outline
Grade 9
Physical Science S
Unit: Magnetism and
Electricity

I. Static Electricity

   A. Process of electrification
   B. Law of charges
   C. Factors affecting charge
   D. The electroscope
   E. Electrical potential energy
   F. Formation and control of lightning

II. Circuits

   A. Basic components of a circuit
      1. Open circuits
      2. Short circuits
   B. Circuit diagrams
   C. Measurement of electricity
      1. Current
      2. Electromotive force
      3. Resistance
      4. Power
   D. Ohm's Law
      1. Application to series circuits
      2. Application to parallel circuits

III. Magnetism

   A. Properties of magnets
   B. Magnetic fields
   C. Domains
   D. Electromagnetism
      1. Solenoid
      2. Motors
      3. Generators, alternating current versus direct current

IV. Electricity in the Home

   A. Fuses and circuit breakers
   B. Electrical transmission and transformers
   C. Power production and usage
      1. Cost calculations
      2. Future sources

OBJECTIVE: To use an electroscope to explore the nature of static charge on a variety of objects

TITLE: "Static Charge"

SOURCE: Teacher developed

OBJECTIVE: To compare circuit types, using operational definitions

TITLE: "Defining Circuits"

SOURCE: Teacher developed from Science, a Process Approach by AAAS

OBJECTIVE: To apply a method for testing the conductivity of various materials and to form operational definitions of the terms "conductor" and "insulator"

TITLE: "Conductors and Insulators"

SOURCE: Teacher developed from Science, a Process Approach by AAAS

OBJECTIVE: To observe and define operationally the function of a fuse in a circuit

TITLE: "Fuses"

SOURCE: Teacher developed from Science, a Process Approach by AAAS

OBJECTIVE: To compare the sum of individual voltage drops to total voltage in a series circuit

TITLE: "Voltage in a Series Circuit"

SOURCE: Teacher modified from Physical Science, a Learning Strategy for the Laboratory by Como, pp. 167-170

OBJECTIVE: To use color coded resistors and compare known circuit resistances with calculated circuit resistances, using Ohm's Law

TITLE: "Resistors"

SOURCE: Teacher developed

OBJECTIVE: To measure the current and voltage in a parallel circuit

TITLE: "Parallel Problems"

SOURCE: Teacher modified from Physical Science, a Learning Strategy for the Laboratory by Como, pp. 175-177

OBJECTIVE: To identify the three factors that affect the strength of an electromagnetic field

TITLE: "Making a Magnet"

SOURCE: Teacher developed from Physical Science, a Learning Strategy for the Laboratory by Como, pp. 161-162

Text Materials

Como, Victor. Physical Science, a Learning Strategy for the Laboratory. Charles E. Merrill Publishing Co., 1977.

Fisk, F.G., and Blecha, M.K. The Physical Sciences. Laidlaw Brothers, 1974.

Films

Electric Power Distribution. Jones Learning Center

Electric Power Generation. Jones Learning Center

Learning About Magnetism. Franklin County Library

Filmstrips -- Hastings Library

Distributing Electric Power

Power Sources of the Future

Transparencies -- Hastings Library

Electrical Meters and Resistance

Supplementary Materials

Columbus and Southern Ohio Electric Company educational kits

Exemplary Activity
Grade 9
Physical Science S
Unit: Magnetism and
Electricity

OBJECTIVE: To use color coded resistors and compare known circuit resistances with calculated resistances, using Ohm's Law

MATERIALS AND EQUIPMENT: Voltmeter, ammeter, DC power supply, resistors, connectors

Discussion:

Experiment indicates that the current through a metallic conductor is directly proportional to the voltage difference between its ends. Mathematically the relation between the current and voltage is stated in Ohm's Law:

$$I = \frac{V}{R}$$

where V is the voltage across the conductor, I is the current in amperes through the conductor, and R is the resistance in ohms.

Often resistors are inserted in a circuit to reduce the current flow. Some standard commercial resistors for use with rather low currents are labeled with a color code.

The color code for resistance is a two digit code and a multiplier given as a power of ten. In the color code, bands of color around the body of the resistor are used to give the resistance and the tolerance of the resistor. Reading from left to right, the first color band is the first digit, the second color band is the second digit, and the third color band is the multiplier. If a fourth color band is used, the band specifies the tolerance rating of the resistor. If no fourth band is used, the tolerance rating of the resistor is 20%.

The table on the next page illustrates the color code for resistors, showing values assigned to each color.

Color	1st Digit	2nd Digit	Multiplier	Tolerance
Black	0	0	10^0	--
Brown	1	1	10^1	--
Red	2	2	10^2	--
Orange	3	3	10^3	--
Yellow	4	4	10^4	--
Green	5	5	10^5	--
Blue	6	6	10^6	--
Violet	7	7	10^7	--
Gray	8	8	10^8	--
White	9	9	10^9	--
Gold	--	--	10^{-1}	5%
Silver	--	--	10^{-2}	10%

PROCEDURE:

List in the data table the color bands of each of the ten resistors, the rated resistance, and the tolerance of each resistance.

Data Table I

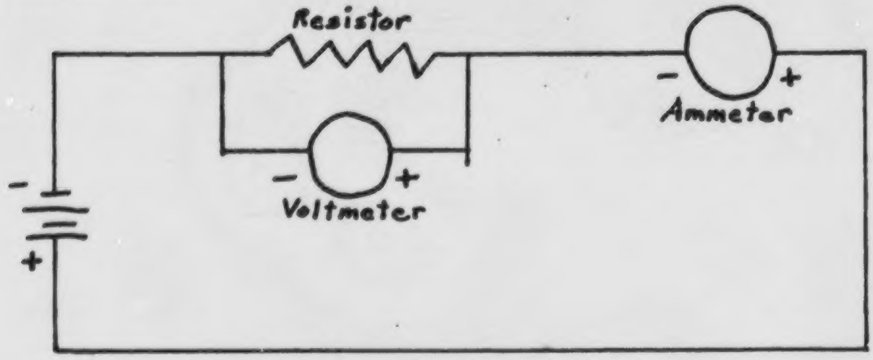
Resistor	Band 1	Band 2	Band 3	Band 4	Resistance	Tolerance	Measured Resistance
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

The simplest electric circuit consists of a power supply and a single resistor in series. By placing an ammeter in the circuit in series with the resistor and connecting a voltmeter in parallel across the resistor, the current through the resistor and the voltage across the resistor can be determined. The resistance can be calculated from the Ohm's Law equation:

$$R = \frac{V}{I}$$

This method of determining resistance is known as the volt-ampere method.

For the volt-ampere method of measuring resistance, the apparatus is set up as in the diagram below.



Measure the current and voltage in each resistor. Record the current and voltage in the table. Calculate the resistance and enter the value in the last column. Compare the calculated resistance value with the value obtained from the color code as you enter the calculated resistance values from Table II in the appropriate column on Table I.

Data Table II

Resistor	Current	Voltage	Resistance Calculated
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Questions

1. If the voltage across a resistor is 8 volts and the current through the resistor is 4 amperes, what is the resistance in ohms of the resistor?

2. If the voltage across a resistor is 12 volts and the current through the resistor is 1.5 amperes, what is the resistance in ohms of the resistor?

Evaluation Sample
Grade 9
Physical Science S
Unit: Magnetism and
Electricity

Section I. Matching. Use choices once or not at all.

____ 1. A device for changing the voltage of alternating current

____ 2. A magnet mounted so that it is free to spin

____ 3. A device for converting mechanical energy to electrical energy

____ 4. Electricity that keeps changing direction through the external circuit

____ 5. Like poles repel, unlike poles attract.

____ 6. Kind of current produced by a generator with a split ring

____ 7. A coil of current-carrying wire with a tubular core

____ 8. Permanent magnet

____ 9. Angle between geographic poles and magnetic poles

____10. Minute atomic particles

A. alnico
B. alternating current
C. angle of declination
D. angle of inclination
E. compass
F. direct current
G. domains
H. electromagnet
I. generator
J. law of charges
K. law of magnetism
L. motor
M. soft iron
N. solenoid
O. transformer

Section II. Multiple Choice. Select the best answer.

____ 1. The lids of metal cans, such as those used to pack food, can be attracted by a magnet on an electric can opener because the cans are made chiefly of (A) tin (B) brass (C) iron (D) copper.

____ 2. A natural magnet is a (A) limonite (B) hematite (C) lodestone (D) limestone.

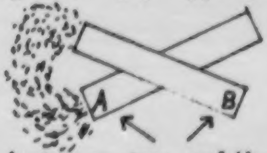
____ 3. The application of heat to a magnet will (A) change its polarity (B) strengthen it (C) weaken it (D) not affect it.

____ 4. The area covered by magnetic lines of force shows (A) direction for force at the S. pole (B) magnitude of force on a compass (C) direction of force at the N. pole (D) extent of the magnetic field.

____ 5. A magnetic field exists around a wire only when the wire (A) is a coil (B) is a loop (C) has a current of electricity through it (D) is straight.

____ 6. When the N pole of a bar magnet approaches a piece of copper, the end of the copper nearest the magnet (A) becomes an S pole (B) repels the magnet (C) is unaffected (D) becomes an N pole.

____ 7. Given the following figures on the two magnets, pole A and pole B, as shown by the lines of force from iron filings, are (A) both S poles (B) both N poles (C) opposite poles (D) the same poles.



____ 8. When the distance between two unlike poles of two magnets is increased 4 times, the force of attraction between these poles is decreased (A) 8 times (B) 4 times (C) 16 times (D) not at all.

____ 9. An electric motor (A) is usually driven directly by a steam turbine (B) changes electrical energy to mechanical energy (C) is always driven by alternating current (D) transforms kinetic energy into electrical energy.

____10. The best material to use as the core of an electromagnet is (A) aluminum (B) steel (C) copper (D) soft iron.

____11. Of the following, the strongest electromagnet is one having (A) 15 amperes and 10 turns (B) 5 amperes and 10 turns (C) 10 amperes and 5 turns (D) 10 amperes and 10 turns.

____12. If the number of turns of wire of the electromagnet in a household bell was increased, the bell would (A) ring louder (B) no longer ring (C) be unaffected (D) ring softer.

____13. Any device that carries an electric current also always produces (A) a magnetic field around it and heat (B) light and heat (C) a magnetic field around it and light (D) heat and motion.

____14. The number of wires entering a house in which large amounts of electric energy are used is usually (A) 2 (B) 1 (C) 4 (D) 3.

____15. A step-up transformer increases the (A) power output (B) energy output (C) current applied at the terminals of the primary (D) voltage supplied at the terminals of the secondary.

____16. A primary coil of a transformer has 200 turns of wire, and the secondary coil has 50 turns. If the voltage applied to the primary is 400 volts, the voltage supplied by the secondary is (A) 100 volts (B) 250 volts (C) 50 volts (D) 25 volts.

____17. If the primary coil of a transformer has 60 turns of wire and the secondary coil has 600 turns, and if there is a current of 20 amperes in the secondary circuit, the current in the primary circuit is about (A) 20 amperes (B) 200 amperes (C) 0.2 amperes (D) 2 amperes.

____18. When the secondary coil of a transformer has one-third as many turns of wire as the primary coil, the induced voltage in the secondary coil as compared to the primary is (A) one-third as great (B) 9 times as much (C) 3 times as much (D) the same.

____19. The current that flows through a 400 watt, 80 volt lamp is (A) 0.2 amps (B) 0.5 amps (C) 5 amps (D) 2 amps.

____20. If an electric iron draws 15 amperes on a 240 volt line and is operated for 5 hours, the power used is (A) 3.6 kilowatts (B) 3.6 kilowatt hours (C) 1.2 kilowatt hours (D) 1.2 kilowatts.

____21. If an electric iron draws 10 amperes on a 120 volt line and is operated for 3 hours, the energy used is (A) 3.6 kilowatt hours (B) 3.6 kilowatts (C) 1.2 kilowatt hours (D) 1.2 kilowatts.

____22. In paying an electric company bill, the consumer pays for (A) the energy used (B) the power used (C) the current drawn (D) the energy times the number of hours electricity is used.

____23. The principal reason for insulation on electric wires is to (A) present a neat appearance (B) prevent corrosion of the wires (C) use for decorative purposes (D) prevent short circuits.

Section III. Increases, Decreases, Remains the Same (I, D, R/S).

____ 1. As the current of an electromagnet decreases, the strength of the magnetic field ________.

____ 2. As the strength of the magnetic fields of two unlike magnets increases, the force of attraction between the two magnets _____.

____ 3. As the number of turns of wire in the primary coil of a transformer increases, the current supplied by the secondary coil _______.

____ 4. In approaching the agonic line, the angle of declination _______.

____ 5. If the amperage goes up on the secondary coil of a transformer, the power out of the transformer _________.

____ 6. As the number of turns of wire in the armature of a generator increases, the voltage produced _______.

____ 7. If the number of hours a 100 watt bulb is used increases, the power _______.

Section IV.

1. Sketch a circuit containing 2 lamps, an ammeter, a switch, and a 3-volt battery in series.

2. Sketch a parallel circuit of 2 lamps, a switch, and a 3-volt battery.

3. Refer to Diagram A. BE SURE TO LABEL ANSWERS WITH CORRECT UNITS!!!

   a. type of circuit ___________

   b. voltage across r_1 ___________

   c. voltage across r_2 ___________

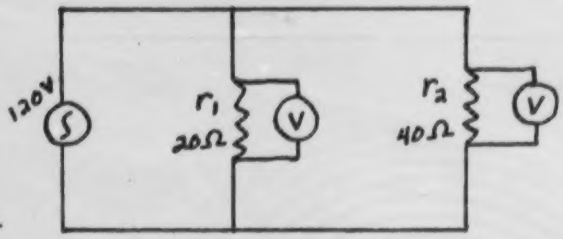
   d. current through r_1 ___________

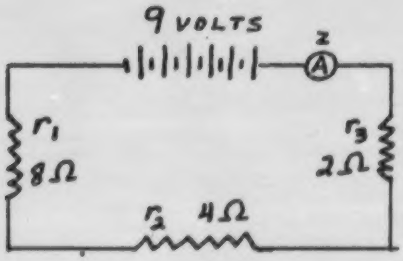
   e. current through r_2 ___________

   f. total current in circuit ________

   g. total resistance in circuit ________

Diagram A





4. Refer to Diagram B.

   a. type of circuit __________

   b. current flow at z __________

   c. total resistance __________

   d. voltage drop across r_1

Bonus. Do only one problem. SHOW WORK. (3 points each)

1. Given two identical needles, A and B, one which is magnetic and one which is not, how can you determine which is the real magnet? The needles may be placed in contact with each other only once and no other materials may be used. (USE A DRAWING.)

2. A family uses the following electrical appliances during one month:

   five 75 watt bulbs for 200 hours
   three 100 watt bulbs for 150 hours
   a 300 watt TV set for 60 hours
   a 1000 watt iron for 10 hours
   a 200 watt refrigerator for 50 hours
   a 14,000 watt stove for 60 hours

   Paying $.05 per kilowatt hour, what will be the electric bill at the end of the month?

3. Is the resistance of a 60W-120V bulb or a 30W-120V bulb greater? Defend your choice.

Unit Outline
Grade 9
Physical Science S
Unit: Motion

I. Describing Motion
   A. Frame of reference
   B. Speed and velocity
   C. Constant speed versus acceleration

II. Why Objects Move
   A. Unbalanced forces
   B. Forces as vector quantities
      1. Finding the resultant
      2. Resolution of forces

III. Newton's Laws of Motion
   A. First law
   B. Second law
   C. Third law

IV. Freely Falling Bodies
   A. Acceleration due to gravity
   B. Terminal speed
   C. Projectile motion

V. Special Kinds of Motion
   A. Up and down
   B. Circular
   C. Pendulums

Suggested Activities
Grade 9
Physical Science S
Unit: Motion

OBJECTIVE: To study the effect of increasing gravitational pull on an elastic object

TITLE: "Force Measurement"

SOURCE: Developed by G. Sweitzer; modified by R. Leininger

OBJECTIVE: To determine factors that affect friction

TITLE: "Force of Friction"

SOURCE: Adapted from Hoover, Kroh et al, Forces and Motion, Board of Education, Baltimore County, 1970.

OBJECTIVE: To study the possible factors that might affect the period of a pendulum and to determine which factor is decisive

TITLE: "Study of a Pendulum"

SOURCE: Teacher developed and modified over a period of time

OBJECTIVE: To explain forces as vectors by means of written information and diagrams and to give students the opportunity to perform activities at the end of each section so that they may better understand the import of the material

TITLE: "Vector Module"

SOURCE: Developed by the teacher after study of a variety of presentations in books and pamphlets

OBJECTIVE: To learn at first hand the effect of changes in mass and/or velocity and to observe conservation of memontum

TITLE: "Study of Momentum"

SOURCE: G. Sweitzer

OBJECTIVE: To provide verification of the laws of motion

TITLE: "Newton's Laws of Motion"

SOURCE: Teacher developed from a variety of sources

Text Materials

Brandwein, et al. "Laws of Motion," *Energy*. 1975, pp. 185-210.

Fisk, Blecha. "Motion," *The Physical Sciences*. Laidlaw Brothers, 1971, pp. 216-245.

Films -- Grandview Heights Public Library

Action, Reaction, 1967

Filmstrips -- Hastings Library

Experiments With Acceleration, SVE

Newton's Laws of Motion, SVE

Film Loops -- Hastings Library

Analysis of a Hurdle Race

Two-Dimensional Collisions

Transparencies

Teacher collection

Exemplary Activity
Grade 9
Physical Science S
Unit: Motion

OBJECTIVE: To realize the difference between vector and scalar concepts and to compute vector quantities

MATERIALS AND EQUIPMENT: Disk, rubber bands, ruler

PROCEDURE:

In studying the concept of motion we have learned:

1. Motion is a change of position of an object.
2. The change in position results from unbalanced forces acting on the object.
3. The change in position can be fully described by
   a. stating the rate at which position is changed, and
   b. the direction the object moves.

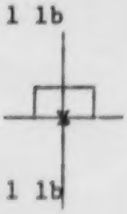
Both forces and changes in position are vector quantities -- that is, they involve both direction and magnitude (amount, distance, or rate).

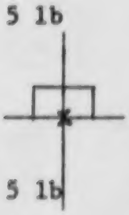
Let us consider first the vector representation of forces. A force has been defined as a push or a pull tending to cause motion. If two forces acting on an object are equal and opposite, no motion will result. Consider an object resting on the floor. Gravity is pulling down on the object, but the floor is pushing up on the object with an equal and opposite force, so the object remains at rest.

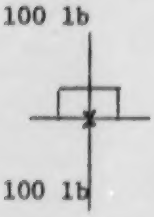
There is an easy way to represent the direction and magnitude of forces acting on a given body. This is by using arrows.

1. The head of the arrow represents the direction of an applied force.
2. The tail of the arrow represents the point at which the force is being applied.
3. The length of the arrow represents the magnitude of the force -- how strong it is.

The length of the arrow is drawn to whatever scale is convenient, depending on the magnitude of the forces in a given situation. The scale must be stated for any given vector. For example, the arrows shown on the next page are all 1/2 inch long, but could represent any equal pairs of forces.







1,000 lb
1,000 lb

Scale:
1/2"=1 lb 1/2"=5 lb 1/2"=100 lb 1/2"=1,000 lb

Drawing vectors

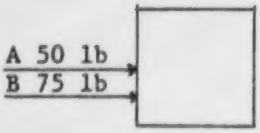
1. Decide on scale to be used and state that scale.
2. Show by the arrowhead the direction the force is acting.
3. Draw a line to scale in the required direction.

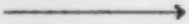
Forces acting in a straight line

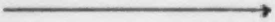
When two forces are acting in a straight line, the resultant, or net force, is found by simple arithmetic -- adding or subtracting the forces.

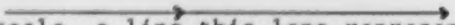
Examples of forces in the same direction:

1. Two boys are pushing a heavy crate, as shown. Since both boys are pushing in the same direction, the effect is the same as if one strong man were pushing with a force equal to the sum of the two boys' efforts.

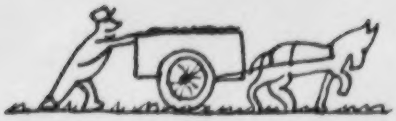


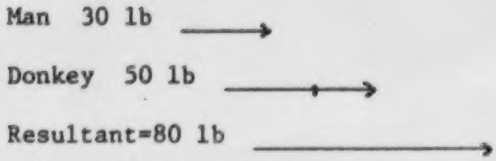
To represent by vectors, let 1/2"=25 lb. A=50 lb, = 

B=75 lb, = 

Combining, we get 
According to our scale, a line this long represents a total force of 125 lb in the direction shown.

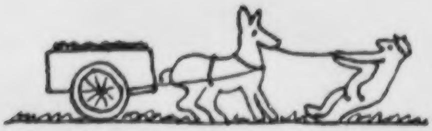
2.

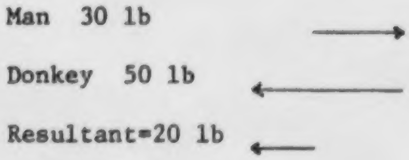



Man 30 lb
Donkey 50 lb
Resultant=80 lb

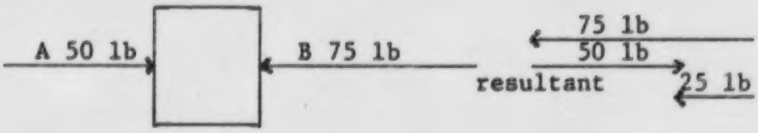
Examples of forces in opposite directions:

1.




Man 30 lb
Donkey 50 lb
Resultant=20 lb

2.


A 50 lb
B 75 lb
75 lb
50 lb
resultant
25 lb

ACTIVITY I. Use separate paper.

Using the disks and rubber bands provided, verify the foregoing examples of forces acting in a straight line.

The disks are to be held motionless while the rubber bands are stretched as shown. The disks are then released. In all cases the rubber bands are to be stretched to equal lengths. (See next page.)

1. For each diagram, first predict what will happen.
2. Test your prediction.
3. Record results by drawing around new location of disk if motion results. Label each new location according to original conditions.
4. Draw a vector diagram of each situation.
5. When you have completed this activity, bring it to your instructor for approval and then continue on to forces acting at angles to each other.

1.

2.

3.

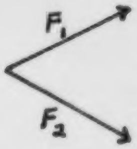
4.

Forces acting at angles to each other

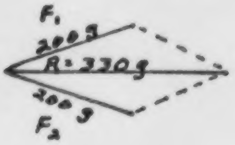
In the majority of cases, forces are acting at angles to each other rather than in a straight-line path. In these cases, a simple geometric technique can be used to find the direction and the magnitude of the resultant or net force -- in other words, how far and in what direction something will move. Steps are:

1. Select a scale and draw the forces given in the proper direction and the proper length for each. The tails of the two arrows must start from the same point.

   Example: Two forces of 200 grams each are acting at an angle of 60 degrees to each other. Scale -- 1 cm = 100 g.



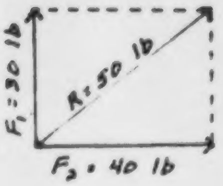
2. Construct a parallelogram using dotted lines. Remember, a parallelogram is a four-sided figure having the opposite sides equal and parallel. The diagonal of the parallelogram is the resultant.



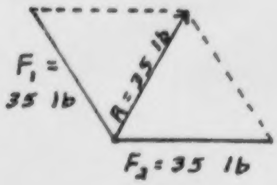
The resultant is the line marked R. By using the correct scale, this is found to be 330 grams.

Further examples of forces acting at angles to each other:

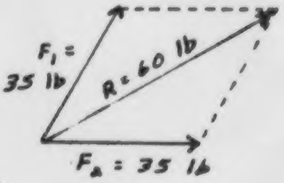
90°



120°

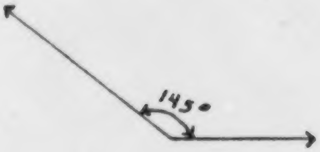


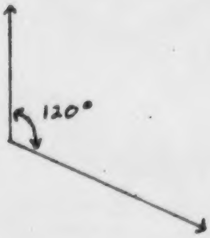
60°

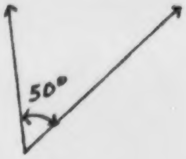


ACTIVITY II. Use separate sheet of paper.

1. Copy the vector diagrams shown and find the resultant. The scale in each diagram is 1 cm = 10 lb.



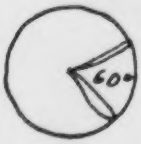




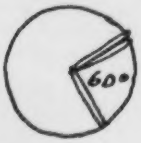
2. Using the wooden disks and rubber bands as shown,

   a. predict results
   b. do and record results

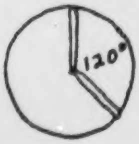
1.



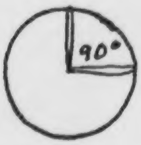
2.



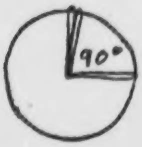
3.



4.

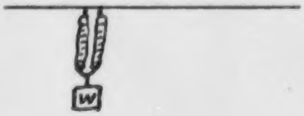


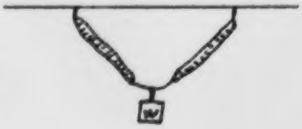
5.

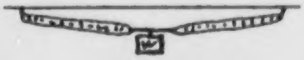


3. Using the force board and a 500 gram weight, determine the readings on the spring scales for at least 3 different locations of the scales.

   a. Measure and record distance between pegs.
   b. Measure and record vertical distance of weight from line on which scales are attached.
   c. Readings on scales







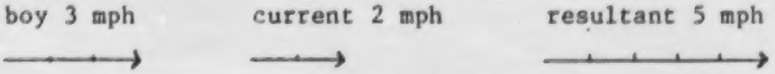
4. Turn in results to instructor.

Velocity vectors

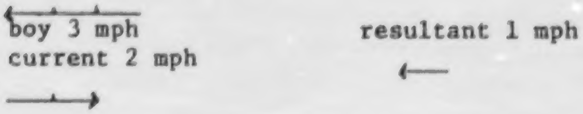
Velocity is another type of vector quantity because it involves both magnitude (speed) and direction. The same rules are followed for finding resultants as in the case of forces.

Example 1. Consider a boy who can row his boat at a rate of 3 mph in still water. He is on a river in which the current is flowing at a rate of 2 mph. Let's examine his progress in each of the following situations:

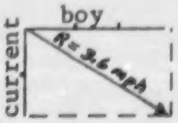
a. Rowing in the same direction as the current -- simple addition.


boy 3 mph
current 2 mph
resultant 5 mph

b. Rowing in the direction opposite to that of the current -- find the difference.

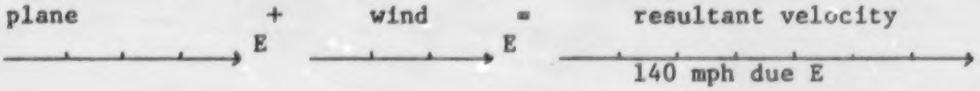

boy 3 mph
current 2 mph
resultant 1 mph

c. Rowing across the river -- at right angles to the current

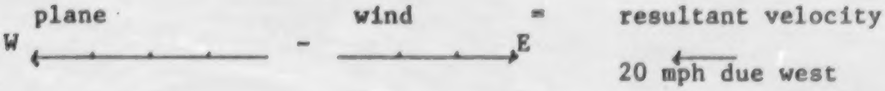

boy
current
R=3.6 mph

Example 2. Consider a small airplane that can fly at 80 mph in still air. On a given day, the wind is blowing at 60 mph. How will the plane move in the following situations?

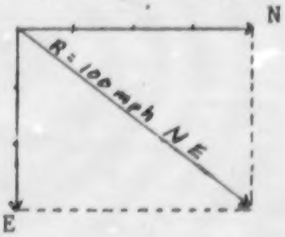
a. The plane is heading due east and has a 60 mph tail wind behind it. What is the resultant velocity?


plane
+
E
wind
E
=
resultant velocity
140 mph due E

b. The plane is heading due west; the wind is blowing due east.


plane
W
-
wind
E
=
resultant velocity
20 mph due west

c. The plane is heading due north at 80 mph and is being blown eastward at the rate of 60 mph. What is the resultant velocity?


N
E
R=100 mph NE

Resolution of vectors

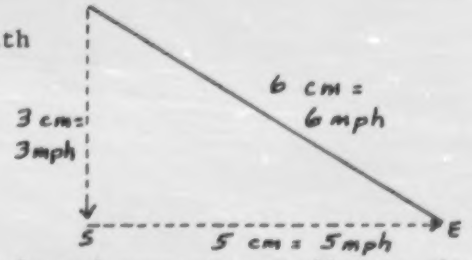
Sometimes we know only the resultant or net force acting on an object and want to know what forces combined to produce that result. The method of finding the original forces or components is called the resolution of the vector.

Go back to the example of the boy rowing across the river. This time you are given only the resultant and the information that the two components are acting at right angles to each other.

Scale: 1 cm = 1 mph

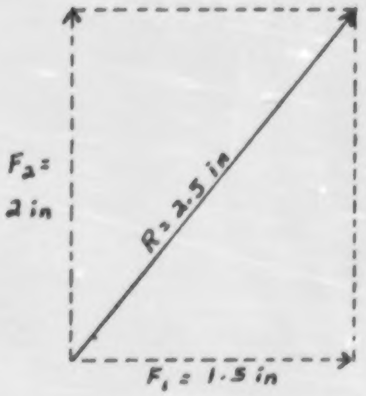
Step 1. Construct a right triangle with the given resultant as the hypotenuse of the triangle.

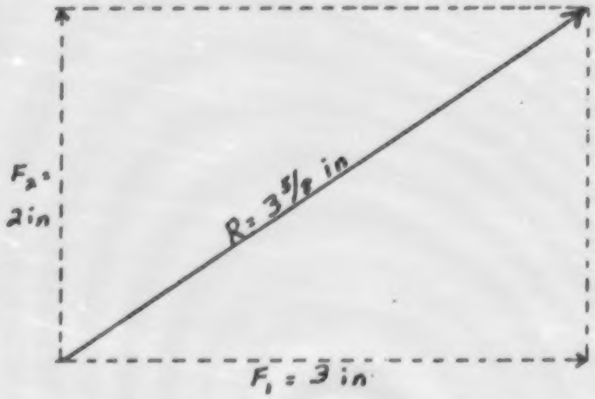
In this example,
current = 3 mph
boy rows at 5 mph



Step 2. Measure the legs of the triangle and convert according to the scale being used.

In the next two examples, the solid line represents a given resultant. In both cases, the components are acting at right angles to each other.





The scale used in both these examples is 1 inch = 20 lb.

In the first case, a resultant of 50 lb in the direction shown is the result of a force of 40 lb upward and a force of 30 lb across.

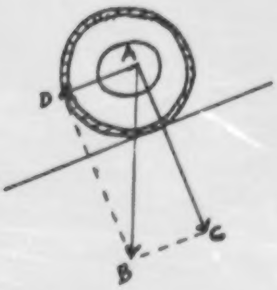
In the second case, the resultant force of 72.5 lb is the net effect of a force of 40 lb acting upward and a force of 60 lb across.

Exemplary Activity (Cont.)
Grade 9
Physical Science S
Unit: Motion

ACTIVITY III

Introduction: The resolution of vectors explains why

1. it is easier to push a barrel up an incline than to lift it; and
2. the less steep the incline, the less effort force is needed to push the barrel.



The component AC represents force exerted by the barrel against the incline and, since the incline pushes back with an equal force, component AC can be disregarded in this activity.

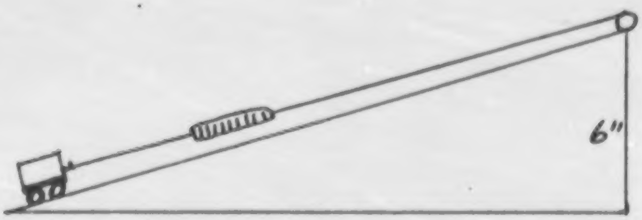
The component AD represents the force needed to move the barrel up the incline and is the force you will be measuring.

The component AD is obviously less than the resultant AB, which represents the weight of the barrel, thus demonstrating that less force is needed to push a barrel up a slope than to lift it.

Procedure:

1. Set up equipment as shown:

   plane
   books to support plane
   spring scale
   string
   wooden or metal cart
   500 gram weight



2. Pull cart with a steady pull while your partner gets a reading on the scale. The needle will fluctuate slightly -- take your reading as nearly in the middle as possible.

   Do 3 trials for each height and record results in table provided.

3. Raise upper end of inclined plane to 12 inches. Do 3 trials at this height and record.
4. Raise upper end to 18 inches. Do 3 trials and record.

Height of plane	Force, Trial 1	Force, Trial 2	Force, Trial 3	Average Force
6 inches				
12 inches				
18 inches				

Analysis of data:

1. How does the steepness of an inclined plane affect the force required to pull a given object up it?

Evaluation Sample
Grade 9
Physical Science S
Unit: Motion

Test: Motion Name ____________________________ Period ____ Date ______

Section I Matching: Use choices once, more than once, or not at all.

____ 1. Change in position of an object

____ 2. That property of mass that causes it to resist any change in its state of motion

____ 3. Rate at which speed increases

____ 4. Rate of motion, direction not stated

____ 5. A push or a pull tending to cause motion

____ 6. Unit suitable for measuring acceleration

____ 7. The ____ of a moving object is equal to its mass times its velocity

____ 8. The maximum velocity an object falling through air reaches

A. acceleration
B. deceleration
C. force
D. friction
E. inertia
F. mass
G. momentum
H. motion
I. meters/second
K. meters/sec/sec
L. speed
M. velocity
N. weight
O. terminal velocity

Section II Multiple Choice

____ 9. An object in free fall is an example of (a) uniform speed (b) uniform velocity (c) uniform acceleration.

____10. Whenever something moves it is the result of (a) balanced forces (b) momentum (c) unbalanced forces (d) friction.

____11. Objects that have inertia are those (a) at rest (b) in motion (c) at rest and also those in motion.

____12. With a given mass, increasing the force applied to it will cause the acceleration of the mass to (a) increase (b) decrease (c) remain the same.

____13. $m_1v_1 = m_2v_2$ is the mathematical expression of the (a) first law of motion (b) second law of motion (c) third law of motion (d) law of conservation of momentum.

____14. An object moves 8 feet in one second, 8 feet in the next second, and 8 feet in the third second. This is an example of (a) constant acceleration (b) constant speed (c) constant deceleration.

Evaluation Sample (Cont.)
Grade 9
Physical Science S
Unit: Motion

____15. Two identical balls are released from a platform at the same time. Ball A is simply rolled off the edge; ball B is shot sideways by a spring. (a) Ball A will strike the ground first. (b) Ball B will strike the ground first. (c) Both balls will strike the ground at the same time.

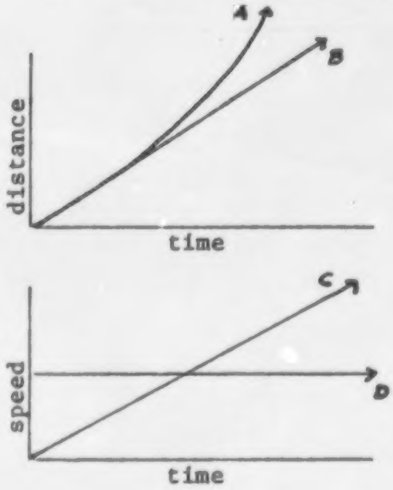
____16. The rate at which velocity changes is known as (a) velocitation (b) acceleration (c) uniform precipitation (d) speed.

____17. The symbol for the acceleration due to gravity is (a) v (b) a (c) d (d) g.

____18. You are standing on a bus that is moving along the street and then stops very suddenly. You will (a) feel no effect (b) lean toward the front of the bus (c) lean toward the rear of the bus.

____19. A piece of cardboard is placed on top of a glass and a steel ball is rested on the cardboard. When the cardboard is flicked away with a finger, the ball falls into the glass. This is because (a) the cardboard has more inertia than the ball (b) the ball has more inertia than the cardboard (c) the cardboard repels the ball.

____20. F = ma is a mathematical expression of which law of motion? (a) first (b) second (c) third

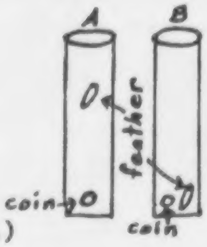


Graphs for 21 and 22

21. Which 2 lines represent constant speed? ________, ________

22. Which line represents constant acceleration? ____________

23. Which of the 2 tubes shown has air in it and which is a vacuum? (Both have just been turned on end and the coin and feather are falling.)



The tube with air is _______.

24. A car travels 400 miles in 8 hours. What is its average speed? ________

25. A car starts from rest and reaches a speed of 120 miles/hour in 12 seconds. What is its acceleration? ________

26. A car starting from rest is moving at 20 mph at the end of 5 seconds. What is its average speed? ________

27. The acceleration due to gravity is 9.8 m/sec/sec. How fast will a falling object be moving at the end of 5 seconds? ________

28. Two people on ice skates face each other. John pushes Bill, but both skaters move away from each other. This is an example of which law of motion? ________________

29, 30. Complete the following table:

time (sec)	velocity (m/sec)	avg. velocity (m/sec)	distance (meters)	total distance (meters)
1	4 m/sec	2 m/sec	2 meters	2 meters
2	________	________	________	________
3	________	________	________	________

Formulas:

$\text{speed} = \frac{\text{distance}}{\text{time}}$

$\text{accel.} = \frac{\text{change in velocity}}{\text{time}}$

distance = velocity x time

velocity = acceleration x time

$\text{time} = \frac{\text{distance}}{\text{velocity}}$

distance = $1/2\ at^2$

$\text{average vel.} = \frac{v_1 + v_2}{2}$

Unit Outline
Grade 9
Physical Science S
Unit: Physical Properties
of Matter

I. Measurement

   A. Metric system, including conversion factors
   B. Significant figures
   C. Scientific notation
   D. Mass vs. weight, emphasizing use of the newton
   E. Graphing
   F. Inverse and direct proportion

II. Energy

   A. Kinetic and potential energy, including formulas
   B. Conversion and transformation

III. Density

   A. Determination, including problem solving for each variable
   B. Application

IV. Liquids

   A. Pressure
      1. Pascal's Law
      2. Hydraulic press
   B. Buoyancy

V. Gases

   A. Boyle's Law, including problems
   B. Charles' Law, including problems

VI. Solubility

   A. Determination
   B. Application

VII. Thermal Energy

   A. Temperature scales
   B. Heat
      1. Transference and transformation
      2. Specific heat
      3. Heat problems
   C. Change of state
      1. Heat of fusion
      2. Heat of vaporization

Suggested Activities
Grade 9
Physical Science S
Unit: Physical Properties of Matter

OBJECTIVE: To determine density of metal paper clips and, by graphing data, to show constant relationship of mass to volume

TITLE: "Investigation of Density: Paper Clip Laboratory"

SOURCE: Teacher developed

OBJECTIVE: To study the relationship between the apparent loss of weight of a completely submerged object and the weight of water it displaces

TITLE: "Weight in Air and Weight in Water"

SOURCE: Teacher developed

OBJECTIVE: To investigate adhesion, cohesion, and surface tension of water

TITLE: "Nature of Drops"

SOURCE: Teacher developed

OBJECTIVE: To observe the differences between solutions and suspensions

TITLE: "Solutions and Suspensions"

SOURCE: Modified from exercise in text: Fisk, Franklin G., and Blecha, Milo K. The Physical Sciences. Laidlaw Brothers, 1971.

OBJECTIVE: To use solubility as a method of determining the identity of an unknown substance

TITLE: "Solubility"

SOURCE: Teacher developed and revised

OBJECTIVE: To observe heat of fusion

TITLE: "Heat of Fusion"

SOURCE: Modified from exercise in text: Bickel, Charles L.; Eigenfeld, Neal D.; and Hogg, John C. Physical Science. D. Van Nostrand Co., 1966.

OBJECTIVE: To determine amount of heat loss or amount of heat gain in water

TITLE: "Heat Loss or Gain"

SOURCE: Teacher developed

Classroom Demonstrations:

Expansion of Gases, Liquids, and Solids
Conduction, Connection, and Radiation
Determination of Final Temperature in Heat Exchange
Effect of Low Pressure on Boiling

Text Materials

Fisk, Franklin G., and Blecha, Milo D. The Physical Sciences. Laidlaw Brothers, 1971, Chapters 2, 3, 4 (pp. 64-76), 7.

Films -- Grandview Heights Public Library

Attraction of Gravity

Buoyancy

How Things Dissolve

Film Loops -- Hastings Library

Air Pressure: Change With Altitude

Density

Mass, Weight, and Volume

Transparencies -- Hastings Library

Heat: Its Measurement, Transfer, and Effects

Exemplary Activity
Grade 9
Physical Science S
Unit: Physical Properties
of Matter

OBJECTIVE: To use solubility as a method of determining the identity of an unknown substance

When you dissolve a substance in a liquid, you make a special kind of mixture called a solution. Sometimes you need to know as much information as possible about a substance in order to identify it. In this lab exercise you will be working with solutions and will identify an unknown by its solubility.

SOLUBILITY IS ALWAYS REPORTED IN GRAMS OF SOLID THAT DISSOLVE IN 100 ML OF LIQUID.

The solid you will use -- unknown.
The liquid you will use -- water.

SOLUBILITY MAY CHANGE AS THE TEMPERATURE OF THE SOLUTION CHANGES.

MATERIALS AND EQUIPMENT: This lab is to be done in groups of 4. Each group will need the following items: balance, ringstand and ringclamp, alcohol lamp, spoon for stirring, thermometer, unknown solid (25 gm), wire screen, graduated cylinder, small beaker

PROCEDURE:

The sample you were given weighed 25 grams (and the paper weighed 1.4 grams). You will get 25 ml of water in your beaker.

Put your beaker on the ringstand and find the temperature of the water. Record on next page. Then add a small amount of the solid and stir in solution. Keep adding the solid in small amounts until you see some solid on the bottom of the beaker. When this happens, the maximum amount of solid has been dissolved at that temperature. Weigh the solid that you have remaining and subtract it from your starting weight (25 gm) to get the weight of the solid dissolved. Record this information on the next page.

Repeat this same procedure at increasing temperatures of 25, 40, 55, 70, and 85°C. Enter the values on the table.

When you have the data table completed, fill in the graph at the bottom of the following page. You will find out what your unknown substance was tomorrow.

You will be graded on how well you follow this procedure and get the correct graph.

It is very important that you record the number of your unknown. You will not be given another unknown substance for any reason; be careful!!!

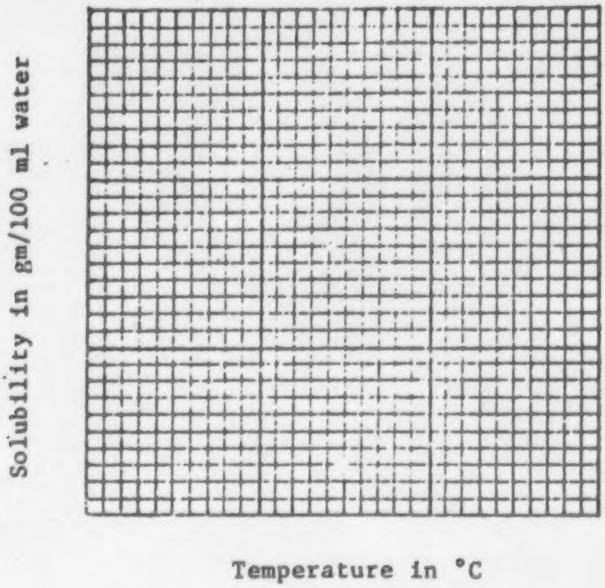
UNKNOWN NUMBER ________

Weight of solid x 4 = solubility

Data Table:

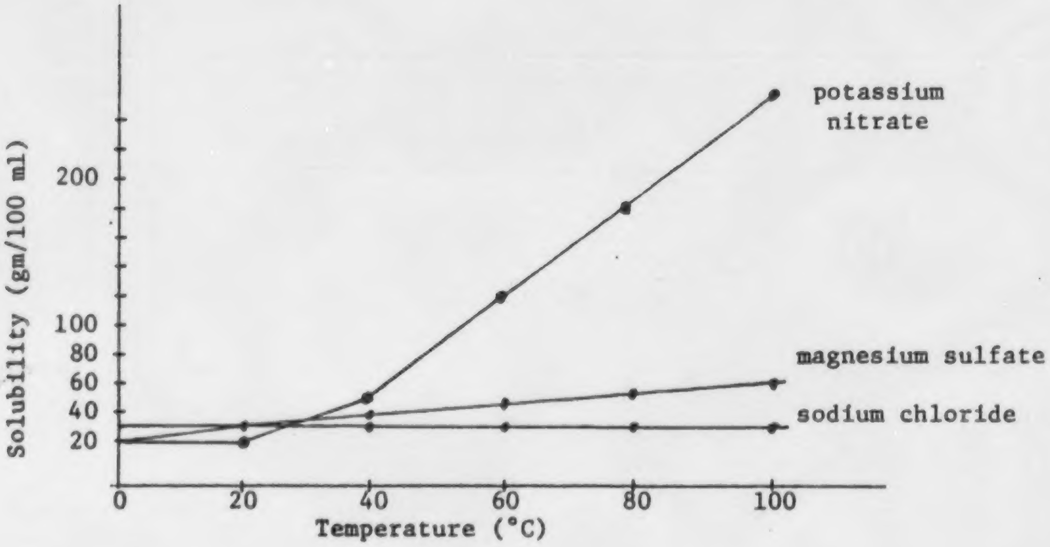
temperature	weight of solid used	amount of water used	solubility (parts/100 ml)
		25 ml	
25°C		25 ml	
40°C		25 ml	
55°C		25 ml	
70°C		25 ml	
85°C		25 ml	

Graph: Plot your temperature and solubility (you should have 6 points).
You must also label the graph.



SOLUBILITY LAB -- Followup

Data Table and Graph: Compare your graph to the one shown below. You should be able to determine what your unknown substance was. If you are not sure, ask the teacher for help.



1. What was your unknown solid?

2. Write definitions of the following words that were important in this experiment.

   solution -

   solubility -

3. What general rule can you state about what happens to the solubility of a substance as temperature increases?

4. Solubility is always given in what units?

5. What number did you have to multiply the weight of your solid by in order to get solubility?

6. Suppose you have a sample of 50 ml of water. What would the solubility be in each of the following cases?

3 grams dissolved ______________________________

7 grams dissolved ______________________________

9.1 grams dissolved ______________________________

7. In which case in #6 do you think the highest temperature of the water would be reached?

8. If you were given two substances with exactly the same density and the same color, how could you find out which one is which?

9. Do the solid and liquid that make up a solution keep their same properties? (HINT -- remember, a solution is a type of mixture.)

10. If a substance has a solubility of 6 grams/100 ml, how much would dissolve in 50 ml?

11. Which of the substances used in this experiment has the highest solubility at 0°C? (HINT -- look at graph.)

12. Which substance has the highest solubility at 80°C?

13. If you were using a sample of 33.3 ml, what would you have to multiply the weight of the substance by in order to get solubility?

WHEN YOU HAVE FINISHED ALL OF YOUR QUESTIONS AND ARE SATISFIED THAT YOU KNOW WHAT YOUR UNKNOWN IS, STAPLE YOUR TWO PAPERS TOGETHER AND HAND THEM IN.

Evaluation Sample
Grade 9
Physical Science S
Unit: Physical Properties
of Matter

Physical Science S -- Test
Density, Buoyancy, Graphing
Form 0

Name ____________________

Period ________ Date ____________

Section I -- Multiple Choice: Select the best answer.

____ 1. Density is (a) weight per unit area (b) weight per unit volume (c) mass per unit area (d) mass per unit volume.

____ 2. A cube has a volume of 27 mm^3. Therefore one side has a length of (a) 2 mm (b) 3 mm (c) 9 mm (d) 8 mm.

____ 3. The most dense samples of matter are found (a) in solutions (b) among solids (c) in liquids (d) in gases.

____ 4. Water at 4°C has a density of (a) 1 gm/cm^2 (b) 1 gm/ml (c) 1 lb/ft^3 (d) 62.4 lb/ft^2.

____ 5. A container holds 500 ml of water. The mass of the water is (a) .5 liters (b) 50 gm (c) 500 gm (c) 500 cm^3.

____ 6. Compared to one pound of cork, one pound of lead is (a) heavier (b) lighter (c) less dense (d) more dense.

____ 7. Methyl alcohol has a density of 0.8 gm/ml. Therefore 1000 ml of methyl alcohol has as much mass as (a) 1000 gm of H_2O (b) 125 ml of H_2O (c) 1000 ml of H_2O (d) 800 ml of H_2O.

____ 8. An object that has a mass of 20 kg weighs (a) 20,000 gm (b) 20 nt (c) 196 nt (d) 200,000 dynes.

____ 9. Given the following densities,

kerosene: 0.80 gm/ml
glycerine: 1.26 gm/ml
ice: 0.92 gm/ml

the conclusion can be made that (a) glycerine will float on ice (b) glycerine will float on kerosene (c) kerosene will float on ice (d) ice will float on kerosene.

____10. The volume of an irregularly shaped solid can be measured by (a) the weight of the object (b) displacement in water (c) the density of the object (d) the volume of air around the solid.

Evaluation Sample (Cont.)
Grade 9
Physical Science S
Unit: Physical Properties
of Matter

____11. A density of 1 gm/cm^3 is equivalent to

(a) $\frac{1\ kg}{L}$ (b) $\frac{10\ kg}{L}$ (c) $\frac{1\ kg}{1000\ L}$ (d) $\frac{1000\ kg}{L}$

____12. The mass of 400 ml of water would be (a) 400 kg (b) 400 gm (c) 400 mg (d) .4 liters.

____13. There is an upward force exerted on an object when it is placed in water and displaces some of the water. This force is called (a) surface tension (b) hydraulic force (c) buoyancy (d) pressure.

____14. If a boat with a mass of 400 kg is floating in a lake, half in and half out, the apparent weight of the boat is (a) 400 kg (b) 0 (c) 200 kg (d) can't tell from the information given.

____15. A piece of metal suspended from a spring scale weighs 200 grams in air. When the metal is lowered into water, the scale reads 160 grams. The volume of the metal is (a) 360 cm^3 (b) 360 ml (c) 160 cm^3 (d) 40 cm^3.

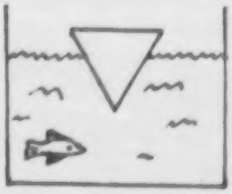
____16. Who formed a principle stating that "any object wholly or partially immersed in a fluid is buoyed up by a force equal to the weight of the displaced fluid"? (a) Newton (b) Einstein (c) Lavoisier (d) Archimedes

____17. If a block is floating in water, the pressure exerted both on the top and the bottom of the block is (a) greater on top (b) greater on the bottom (c) equal (d) dependent on the shape of the object.

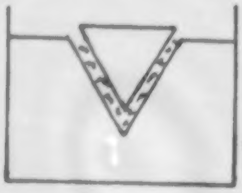
____18. An object placed in water sinks so that only 1/3 of it is above the water. Its density is, therefore, approximately
(a) 1.33 $\frac{gm}{cm^3}$ (b) 6.67 $\frac{gm}{cm^3}$ (c) 0.33 $\frac{gm}{cm^3}$ (d) unable to be determined

The drawings below represent a ship with a displacement of 30,000 tons in three different locks. The ship floats at the same level in each.

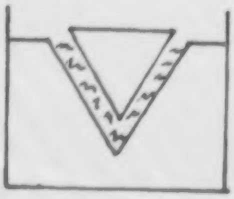
1.



2.



3.



____19. The buoyant force on the ship is the (a) greatest in 1 (b) least in 3 (c) same in all (d) unable to be determined.

____20. An object weighs 400 grams and has a volume of 600 cm^3. If placed in water,

__________(a) Will it sink or float?

__________(b) What weight of water will it displace?

__________(c) What will be the apparent weight of the block?

__________(d) How much of the block will be in the water?

Section II -- Increases, Decreases, Remains the Same: Use I for increases, D for decreases, and RTS for remains the same.

____ 1. If the mass of an object remains the same but its volume increases, its density ____.

____ 2. As the volume of water flowing into a sink increases, its density ____.

____ 3. As the density of a fluid increases, its buoyancy ____.

____ 4. a. If a metal block is lowered into a beaker of water and held suspended, the weight of the object will ____.
b. The mass of the object will ____.

____ 5. As a rigid airship such as a blimp rises, the buoyant force of the air ____.

____ 6. As a ship moves from sea water to fresh water, the volume of water it displaces ____.

Section III -- Problem: Use the 4-step method and SHOW YOUR WORK.

A king had a crown of gold with a mass of 760 gm. The density of gold is 19 gm/cm^3. He placed it in a tub of water to find the volume. What was the volume?

Evaluation Sample (Cont.)
Grade 9
Physical Science S
Unit: Physical Properties
of Matter

Bonus -- Do only one.

A. (3 points) Can you make up a different method, other than weight per unit volume, that might be used for comparing different substances?

B. (2 points) There are two beakers completely filled with water and they weigh the same. If a wooden block is placed in one beaker, will the beaker weigh more, less, or the same? (Explain)

Unit Outline
Grade 9
Physical Science S
Unit: Chemical Properties
of Matter

I. Structure of Matter

- A. Structure of the atom
  - 1. Bohr model
  - 2. Quantum model -- energy levels and electron configuration
  - 3. Ions
  - 4. Isotopes
- B. Periodic chart
  - 1. Names and symbols of the elements
  - 2. Atomic number
  - 3. Atomic mass
  - 4. Groups and periods
  - 5. Metals and nonmetals
- C. Compounds
  - 1. Naming compounds
  - 2. Formula writing
  - 3. Bonding -- ionic and covalent
  - 4. Moles
- D. Reactions
  - 1. Balancing equations
  - 2. Classification

II. Descriptive Chemistry

- A. Properties of acids, bases, and salts
- B. Properties of oxygen, hydrogen, and nitrogen
- C. Comparative reactivity of metals
- D. Properties of carbon
  - 1. Fuels
  - 2. Destructive distillation
  - 3. Fractional distillation

OBJECTIVE:	To gain experience working with glass tubing in making a useful product
TITLE:	"How to Make a Dropper"
SOURCE:	Teacher developed

OBJECTIVE:	To illustrate the principles applied in developing the periodic classification of the elements
TITLE:	"Making a Periodic Chart"
SOURCE:	Teacher developed from Interaction of Matter and Energy by Abraham, et al., pp. 82-101.

OBJECTIVE:	To arouse interest in making models of atoms of different elements
TITLE:	"Atom Hopping"
SOURCE:	Teacher developed from Action Chemistry by Bolton, et al., pp. 4/19-4/21.

OBJECTIVE:	To identify substances on the basis of physical and/or chemical properties
TITLE:	"Flame Tests and Iodine Test"
SOURCE:	Teacher developed from Spaceship Earth by Hill and Barcaski.

OBJECTIVE:	To produce a heavier-than-air gas and to enumerate some of its chemical and physical properties
TITLE:	"Preparation of CO_2"
SOURCE:	Teacher developed from A Sourcebook for the Physical Sciences by Joseph, et al.

OBJECTIVE: To identify the differences between mixtures and compounds

TITLE: "Mixtures and Compounds"

SOURCE: Teacher developed

OBJECTIVE: To analyze the relative reactivities of selected metals and to suggest possible equations to explain the observed reactions

TITLE: "The Activity of Metals"

SOURCE: Teacher developed

OBJECTIVE: To identify the properties of acids and bases

TITLE: "Testing for Acids and Bases"

SOURCE: Interaction of Matter and Energy by Bolton, et al., pp. 114-115.

OBJECTIVE: To become familiar with the pH scale and to apply pH in the analysis of soil

TITLE: "pH Scale"

SOURCE: Teacher developed

OBJECTIVE: To compare acid and base properties using indicators

TITLE: "Indicators"

SOURCE: Teacher developed from Action Chemistry by Bolton, et al, pp. 3/4-3/7.

OBJECTIVE: To apply chemical principles in the production of a useful product

TITLE: "Milk of Magnesia"

SOURCE: Teacher developed from Action Chemistry by Bolton, et al., pp. 5/16-5/17.

OBJECTIVE: To identify the differences between solutions and suspensions

TITLE: "Solutions and Suspensions"

SOURCE: Teacher developed from The Physical Sciences by Fisk and Blecha.

OBJECTIVE: To estimate the size of particles of matter

TITLE: "Another Look at Size"

SOURCE: Interaction of Matter and Energy by Abraham, et al., pp. 50-52.

OBJECTIVE: To show the relationship of atomic masses of elements and compounds to moles

TITLE: "Moles"

SOURCE: Teacher developed from Action Chemistry by Bolton, et al., pp. 4/41-4/45.

OBJECTIVE: To become familiar with a model for the arrangement of atoms in a compound

TITLE: "Model Building"

SOURCE: Teacher developed from Action Chemistry by Bolton, et al., pp. 4/16-4/18.

Suggested Activities (Cont.)
Grade 9
Physical Science S
Unit: Chemical Properties
of Matter

OBJECTIVE: To gain evidence that neutral atoms might gain or lose electrons to form ions

TITLE: "Charged Particles in Solution"

SOURCE: Interaction of Matter and Energy by Abraham, et al., pp. 74-75.

OBJECTIVE: To show that mass is conserved in a chemical reaction

TITLE: "Chemical Reaction and Mass"

SOURCE: Teacher developed from Action Chemistry by Bolton, et al., pp. 5/2-5/3.

OBJECTIVE: To construct model compounds using construction paper, and to illustrate the positive and negative relationships

TITLE: "Cut-outs"

SOURCE: Teacher developed

OBJECTIVE: To illustrate a synthesis reaction and identify the changes in properties that occur

TITLE: "Direct Union"

SOURCE: Teacher developed

OBJECTIVE: To illustrate a decomposition reaction and identify the changes in properties that occur

TITLE: "Electrolysis"

SOURCE: Teacher developed

Suggested Activities (Cont.)
Grade 9
Physical Science S
Unit: Chemical Properties
of Matter

OBJECTIVE: To illustrate a series of double replacement reactions and to observe the similarities in properties among elements in the same chemical family

TITLE: "Double Replacement"

SOURCE: Teacher developed from Action Chemistry by Bolton, et al., pp. 5/18-5/19.

Resources
Grade 9
Physical Science S
Unit: Chemical Properties
of Matter

Text Materials

Abraham, Bolch, Chaney, and Rohrbaugh. Interaction of Matter and Energy. Rand McNally and Co., 1973, pp. 35, 120-121, 123-124.

Bolton, Ruth P., Lamphere, Elizabeth V., et al. Action Chemistry. Holt, Rinehart and Winston, Inc., 1973.

Fisk, Franklin G., and Blecha, M.K. The Physical Sciences. Laidlaw, 1971, pp. 45, 56, 84-101.

Hill and Barcaski. Spaceship Earth. Houghton Mifflin, 1974.

Films

Chemistry and Man -- Modern Talking Pictures

Chemistry: Formulas and Equations -- Franklin County Library

A Grain of Salt -- Modern Talking Pictures

How Atoms Combine -- Franklin County Library

Two for Fox, Two for Crow -- Modern Talking Pictures

Types of Chemical Change -- Franklin County Library

Filmstrips -- Jones Learning Center

Acids and Bases

The Nature of Matter: Chemical Reaction

Periodic System

Film Loops -- Hastings School

Electron Orbits

Electron Shells

Introducing Atoms

Transparencies -- Hastings School

Chemistry

Exemplary Activity
Grade 9
Physical Science S
Unit: Chemical Properties
of Matter

OBJECTIVE: To analyze the relative reactivities of selected metals and to suggest possible equations to explain the observed reactions

MATERIALS AND EQUIPMENT: 4 test tubes; beaker; 3 strips each of copper, lead, and zinc; solutions of cupric nitrate, zinc nitrate, and silver nitrate; magnesium strip; iron; hydrochloric acid

Note: If a metal is more active than the one in solution, a chemical reaction will occur. A reaction is indicated if

A. there is a change of color on the strip or in the solution, or
B. the metal in the solution, such as the copper in cupric nitrate, plates out onto the metal strip.

Caution: Silver nitrate will cause discoloration if it comes in contact with your skin.

Section I.

PROCEDURE:

1. Fill separate test tubes 1/3 full of each nitrate except lead nitrate. Label your solutions so you can identify them. Put a piece of lead in each. (Write either reaction or no reaction on the line provided.)

   Observations:

   A. in copper nitrate ____________________

   B. in zinc nitrate ____________________

   C. in silver nitrate ____________________

2. Repeat, using each nitrate except zinc nitrate. Put a piece of zinc in each test tube.

   Observations:

   A. in copper nitrate ____________________

   B. in silver nitrate ____________________

   C. in lead nitrate ____________________

671

3. Repeat, using each nitrate except copper nitrate. Put a piece of copper in each test tube.

Observations:

A. in zinc nitrate ____________________

B. in lead nitrate ____________________

C. in silver nitrate ____________________

Using the preceding data, fill in the following table. Put a + in the square if the metal reacted in the solution, and leave the square blank if it did not.

	cupric nitrate	silver nitrate	lead nitrate	zinc nitrate
lead				
zinc				
copper				

Conclusions:

A. From the above table, rank the four metals according to their activity. Begin with the most active.

1.____________________ 3.____________________

2.____________________ 4.____________________

B. Write formulas for all of the compounds used in this investigation.

1.____

2.____

3.____

4.____

C. Write a balanced chemical equation for one of the reactions in parts 1, 2, and 3.

1.____

2.____

3.____

Section II.

PROCEDURE:

Place small quantities of zinc, magnesium, iron, and copper into four small test tubes, a different metal in each test tube. Pour a little dilute hydrochloric acid into each test tube. Observe the rate of the reaction by noticing the production of hydrogen gas if a reaction occurs. The more active the metal, the more vigorous the reaction.

Observations:

1. Zinc and HCl ____

2. Magnesium and HCl ____________________________________

3. Iron and HCl ____

4. Copper and HCl ______________________________________

Which metal is most active? _______________________

Which metal is least active? ______________________

Evaluation Sample
Grade 9
Physical Science S
Unit: Chemical Properties
of Matter

Section I. Matching. Use choices once or not at all.

____ 1. Scale used for determining relative acidity of a solution

____ 2. Substance made by combining oxygen with an element

____ 3. A solution that turns red litmus paper blue

____ 4. An element found in all acids and bases

____ 5. Represents a molecule

A. acid
B. base
C. formula
D. hydrogen
E. pH
F. oxygen
G. oxide
H. symbol
I. titration

Section II. Multiple choice. Select the best answer.

____ 1. The name iron III sulfate indicates (A) the valence number of iron is +3 (B) iron has three different valence numbers (C) three atoms of iron in the compound (D) the valence number of sulfate is -3.

____ 2. An atom becomes positively charged by (A) gaining protons (B) losing protons (C) gaining electrons (D) losing electrons.

____ 3. The symbol Na^{+1} represents a/an (A) ion (B) atom of a metal (C) atom of a nonmetal (D) base.

____ 4. Oxidation in which heat and light are given off is called (A) corrosion (B) combustion (C) rusting (D) decay.

____ 5. A catalyst always (A) slows down a reaction (B) changes the speed of a reaction (C) speeds up a reaction (D) is decomposed.

____ 6. The correctly balanced equation for the laboratory preparation of oxygen is:

(A) $KClO_3 \longrightarrow KCl + O_2$

(B) $2\,KClO_3 \longrightarrow 2KCl + 2O_3$

(C) $2\,KClO_3 \longrightarrow KCl + O_2$

(D) $2\,KClO_3 \longrightarrow 2KCl + 3O_2$

____ 7. The number of atoms in one molecule of aluminum sulfate $Al_2(SO_4)_3$ is (A) 10 (B) 5 (C) 17 (D) 13.

____ 8. In a chemical reaction, the number of atoms of each element in the products as compared to the reactants is (A) greater (B) less (C) varies according to the reaction (D) the same.

____ 9. Carbon dioxide is used as a fire extinguisher because it (A) removes oxygen from the air (B) is soluble in water (C) is heavier than air (D) reacts with water to form carbonic acid.

____10. Soda pop fizzes because it contains (A) color and flavoring (B) sugar (C) baking soda (D) carbon dioxide.

____11. A glowing splint is thrust into a bottle containing a gas. If the splint bursts into flame, the gas in the bottle is (A) hydrogen (B) steam (C) oxygen (D) carbon.

____12. A metallic oxide, when placed in water, will form (A) a base (B) an acid (C) a salt (D) no other substance, remaining unchanged.

____13. The rusting of iron is an example of (A) a catalyst (B) slow oxidation (C) rapid oxidation (D) combustion.

____14. When an acid and base are put together, the compound formed by the negative ion of the base and the positive ion of the acid is (A) salt (B) base (C) acid (D) water.

____15. The reaction between an acid and a base to form a salt and water is called (A) neutralization (B) oxidation (C) replacement (D) decomposition.

____16. An acid is a substance that (A) only reacts with a metal (B) dissolves in water to give a salt (C) gives positively charged ions in water solution (D) gives hydrogen ions in water solution.

____17. An example of a base is (A) sodium hydroxide (B) sodium nitrate (C) sodium sulfate (D) sodium chloride.

____18. An example of an acid is (A) magnesium chloride (B) hydrogen chloride (C) sodium chloride (D) sodium sulfate.

____19. Of the following, all are strong acids except (A) nitric (B) carbonic (C) sulfuric (D) hydrochloric.

____20. An example of a salt is (A) calcium hydroxide (B) calcium sulfate (C) calcium oxide (D) carbon dioxide.

____21. Of the following, the compound that is an oxide is (A) $KClO_3$ (B) HgO (C) H_2SO_4 (D) $AgNO_3$.

____22. An example of an oxide that reacts with water to form an acid is (A) potassium oxide (B) sulfur dioxide (C) barium oxide (D) calcium oxide.

____23. Given the following amu, H-1, N-14, S-32, the amount in grams needed in using one mole of the reactant $(NH_4)_2S$ is (A) 68 (B) 86 (C) 54 (D) 64.

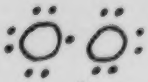
____24. Acid M and acid L are titrated to determine their relative strengths. Twice as much of the base used is needed to neutralize acid L. Therefore the strength of acid L as compared to acid M is (A) equal (B) half as much (C) not really determined (D) twice as much.

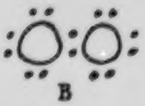
____25. An indication of a chemical change in a substance occurs when (A) it dissolves in water (B) it changes from a liquid to a gas (C) it changes color (D) all of the previous answers take place.

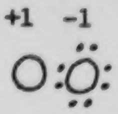
____26. If a substance has a pH of 4, it is a/an (A) base (B) salt (C) water (D) acid.

____27. A compound has the formula XY_3. If X has a valence of +3, Y has a valence of (A) -3 (B) -9 (C) +1 (D) -1.

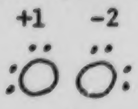
The following figures that represent bonding apply to questions 28 and 29. The circles represent the atoms X and Y and the dots represent electrons.


A


B



C



D

____28. The above figure that illustrates ionic or electrovalent bonding is Figure A, B, C, or D.

____29. The above figure that represents covalent bonding is Figure A, B, C, or D.

____30. The extremely active metals and nonmetals are usually found (A) combined with other elements (B) free in nature (C) sometimes free and sometimes combined (D) cannot be determined.

For questions 31 through 34, given the following information, determine the relative activity of the metals A, B, C, and D.

Metal A is placed in solutions of B nitrate, C nitrate, and D nitrate.
Results: B nitrate -- no reaction
C nitrate -- reaction
D nitrate -- no reaction

Metal B is placed in solutions of A nitrate, C nitrate, and D nitrate.
Results: A nitrate -- reaction
C nitrate -- reaction
D nitrate -- no reaction

Evaluation Sample (Cont.)
Grade 9
Physical Science S
Unit: Chemical Properties
of Matter

Metal C is placed in solutions of A nitrate, B nitrate, and D nitrate.

Results: A nitrate -- no reaction
B nitrate -- no reaction
D nitrate -- no reaction

____31.

____32.

List the activity of each metal, beginning with the most active down to the least active.

____33.

____34.

Section III.

1. In Part A, balance the equations. The formulas are correctly given.

2. In Part B, write the letter showing the type of chemical reaction.
   - S -- synthesis
   - D -- decomposition
   - SR -- single replacement
   - DR -- double replacement

Part A

1. $Fe_2O_3 + C \longrightarrow Fe + CO_2$
2. $AlN + H_2SO_4 \longrightarrow Al_2(SO_4)_3 + H_3N$

Part B

________________ 1.

________________ 2.

Bonus. Do just one.

A. (1 point) Explain why gold is often used to fill and cap teeth.

B. (2 points) In the reaction:

$$HCl + NaOH \longrightarrow NaCl + H_2O$$

1/4 mole of HCl and 1/2 mole of NaOH are used. What will be the amount of NaCl produced?

____

C. (3 points) The following reactions were performed to test the activity of iron, hydrogen, copper, silver, and lead. From the information given from these reactions, arrange the five elements in order of decreasing activity.

____ 1.

____ 2.

____ 3.

____ 4.

____ 5.

(A) $Cu + HCl \longrightarrow$ no reaction

(B) $Pb + 2\ HCl \longrightarrow PbCl_2 + H_2$

(C) $Fe + Pb\ (NO_3)_2 \longrightarrow Fe\ (NO_3)_2 + Pb$

(D) $Cu + 2AgNO_3 \longrightarrow Cu\ (NO_3)_2 + 2\ Ag$

Unit Outline
Grade 9
Physical Science S
Unit: Nuclear Energy

I. Nuclear Changes
  - A. Discovering radioactivity
  - B. Types of radiation
  - C. Ways of detecting radioactivity
    - 1. Cloud and bubble chambers
    - 2. Emulsions
    - 3. Geiger counter

II. The Nature of Radioactivity
  - A. Nuclear changes and reactions
  - B. Artificial radioactivity
  - C. Rate of decay
    - 1. Half-life
    - 2. Carbon dating
  - D. Reactors
    - 1. Fission
    - 2. Possibilities of fusion
  - E. Radioactivity and health

III. Writing Nuclear Equations
  - A. Transmutations
  - B. Uranium^{238} decay series

Suggested Activities
Grade 9
Physical Science S
Unit: Nuclear Energy

OBJECTIVE: To make observations about the properties of radioactive substances

TITLE: "A Home Cloud Chamber"

SOURCE: Teacher modified from The Physical Sciences by Fisk and Blecha

OBJECTIVE: To observe the penetrating ability of particles emitted by the nuclei of radioactive atoms

TITLE: "Using the Geiger-Müller Counter"

SOURCE: Teacher modified from The Physical Sciences by Fisk and Blecha

OBJECTIVE: To develop a model of radioactive decay, use the model to generate data for a decay curve, and apply the half-life of carbon-14 in predicting the age of a given sample

TITLE: "Laboratory: Half-Life"

SOURCE: Ramsey, et al. Physical Science. Holt, Rinehart, and Winston, 1978, p. 441

OBJECTIVE: To illustrate controlled and uncontrolled chain reactions

TITLE: "Domino Models of Chain Reactions"

SOURCE: Teacher developed from Physical Science by Ramsey, et al.

Resources
Grade 9
Physical Science S
Unit: Nuclear Energy

Text Materials

Fisk, Franklin G., and Blecha, Milo D. The Physical Sciences. Laidlaw Brothers, 1971, pp. 187-213.

Films

Atomic Energy: Inside the Atom -- Columbus Public Library

Atomic Radiation -- Columbus Public Library

The Atom: Underground -- Indiana University

Learning About Nuclear Energy -- Grandview Heights Public Library

Our Friend the Atom -- Grandview Heights Public Library

Radioactivity -- Indiana University

Radioisotopes: Tools of Discovery -- Indiana University

U^{238} Radioactive Series -- Columbus Public Library

Filmstrips

Atomic Detectives -- Hastings Library

Harnessing the Atom -- Jones Library

Making Atomic Energy Help Mankind -- Hastings Library

Putting Atomic Energy to Work -- Hastings Library

Pamphlets

Fowler, John M. "Factsheet #12, Conventional Reactors," National Science Teachers Association and Energy Research and Development Administration, P.O. Box 62, Oak Ridge, TN 37830.

Fowler, John M. "Factsheet #13, Breeder Reactors," National Science Teachers Association and Energy Research and Development Administration, P.O. Box 62, Oak Ridge, TN 37830.

Pamphlets (Cont.)

Fowler, John M. "Factsheet #14, Nuclear Fusion," National Science Teachers Association and Energy Research and Development Administration, P.O. Box 62, Oak Ridge, TN 37830.

Articles

Diamond, Stuart. "Where the Atom Splits," Omni. November 1978, pp. 115-117.

Field Trip

O.S.U. Van de Graaf Center

Reference:

Ramsey, et al. "Laboratory: Half-Life," Physical Science. Holt, Rinehart, and Winston, 1978, p. 441.

Evaluation Sample
Grade 9
Physical Science S
Unit: Nuclear Energy

Reference:

Perkins, Otho E., and Galembo, Milton. Physical Science, Cambridge Work-a-Text. Cambridge Book Co., 1974, chapters 13 and 14, pp. 123-126, 133-135.

Unit Outline
Grade 9
Physical Science S
Unit: Mechanics

I. Work
    - A. Scientific definition
    - B. Determination in both English and metric units

II. Power
    - A. Horsepower
    - B. Watts

III. Machines
    - A. Definition
    - B. Uses
    - C. Simple and compound
    - D. Mechanical advantage
    - E. Efficiency
    - F. Force of friction

IV. Problems Involving Simple Machines Using Joules and Ft.-Lb.
    - A. Three classes of levers
    - B. Wheel and axle
    - C. Pulleys
        - 1. Combinations
        - 2. Belt-driven pulleys
    - D. Gears
    - E. Inclined plane

V. Internal Combustion Engine
    - A. Two stroke
    - B. Four stroke

Suggested Activities
Grade 9
Physical Science S
Unit: Mechanics

OBJECTIVE: To determine the force of friction and the effect of different surfaces upon it

TITLE: "Friction"

SOURCE: Teacher developed

OBJECTIVE: To determine all possible MA's of the three classes of levers

TITLE: "Levers"

SOURCE: Teacher developed

OBJECTIVE: To determine the MA of combinations of both fixed and movable pulleys with the direction of the pull, both up and down

TITLE: "Pulleys"

SOURCE: Teacher developed

Classroom Demonstrations:

Practical applications of each of the three kinds of levers

Wheel and axle
Hydraulic press
Gears
Internal combustion models

Resources
Grade 9
Physical Science S
Unit: Mechanics

Text Materials

Fisk, Franklin G., and Blecher, Milo D. The Physical Sciences. Laidlaw Brothers, 1971, Chapter 11 (pp. 246-255), Chapter 13.

Film Loops -- Hastings Library

Simple Machines Series
    Includes:
        Lever II
        Lever III
        Pulley I
        Pulley II
        The Screw
        The Gear

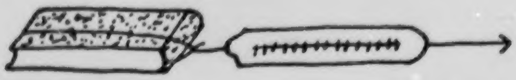
Exemplary Activity
Grade 9
Physical Science S
Unit: Mechanics

OBJECTIVE: To determine the force of friction and the effect of different surfaces upon it

MATERIALS AND EQUIPMENT: String cord, books, spring scale, triple beam balance

PROCEDURE:

A. Attach a cord around a book as shown in the diagram. Attach the spring scale to the cord. Applying a constant pull to the spring scale, obtain several readings of the force necessary to start the book in motion.



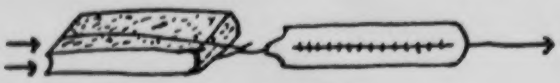
Observations:

1. Record the average force. ______________________________
2. Compare the magnitude of the applied force to the weight of the book.

   ____

3. Explain the results obtained in question 2.

B. Determine the magnitude of the force required to keep the book moving after it is already in motion.

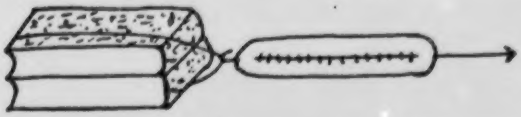


Force necessary to overcome sliding friction

Observations:

1. Results of the average applied force ___________________________
2. What do you conclude after comparing starting friction (Part A) to sliding friction?

C. Determine the magnitude of the force applied to the book after another book has been placed on top of it. The force should be determined after the book is in motion. Then repeat this for three books and then for four books. (Science books may be too heavy, so use four smaller books.)

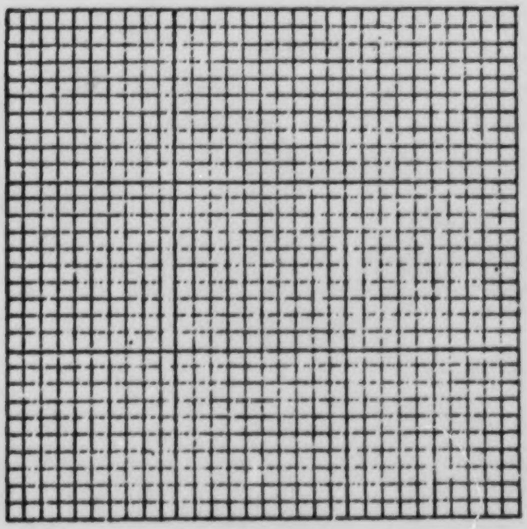


Observations:

Table:

Number of books	Books		Force of friction	
	gm	nt	gm	nt
1				
2				
3				
4				

Prepare a graph of data. Plot weight of the books along the horizontal axis (the abscissa or x-axis) and the force of friction along the vertical axis (the ordinate or y-axis). Use 0 in the lower left hand corner.

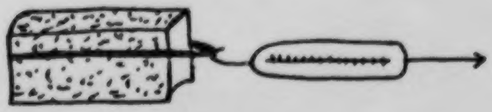


Questions

1. On the basis of the graph, what relationship does there appear to be between the force pressing the book (or books) against the table and the force of friction? Remember that the force pressing the books against the table is the weight of the books.

2. If the symbol "W" represents the weight of the books and the symbol "F" represents the force of friction, what is the simple relationship between F and W as indicated by the data and also by the graph?

D. Place the book on its end and record the average force necessary to start it in motion.



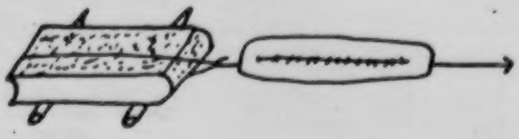
Force necessary to overcome starting friction

Observations:

1. Results of the applied force ______________________________

2. What do you conclude by comparing the results of the force required to put the book in motion when placed flat on the table (Part A) and when placed on edge?

E. Determine the magnitude of the applied force needed to keep the book in motion after two or three pencils are placed below the book.



Observations:

1. Results of the average applied force ______________________________

2. Compare the use of the pencils in the above case with the use of machine ball bearings.

Exemplary Activity (Cont.)
Grade 9
Physical Science S
Unit: Mechanics

OBJECTIVE: To determine all possible MA's of the three classes of levers

MATERIALS AND EQUIPMENT: Meter stick, meter stick holder, clips to hold meter and masses, spring scales (weight of meter sticks must be considered for completely accurate results)

PROCEDURE:

Part A. Using the meter stick holder, determine the center of gravity of the meter stick, i.e., the point at which it balances. Place the mass-holding clips equidistant from the center of gravity. Complete the table.

	Masses	Force	Distance from fulcrum
Resistance	______	_____	____________________
Effort	______	_____	____________________
MA	$\frac{R}{E}$ = ____________		$\frac{E\ dist}{R\ dist}$ = ____________

Part B. Place the fulcrum closer to the resistance.

	Masses	Force	Distance from fulcrum
Resistance	______	_____	____________________
Effort	______	_____	____________________
MA	$\frac{R}{E}$ = ____________		$\frac{E\ dist}{R\ dist}$ = ____________

Part C. Place the fulcrum closer to the effort.

	Masses	Force	Distance from fulcrum
Resistance	______	_____	____________________
Effort	______	_____	____________________
MA	$\frac{R}{E}$ = ____________		$\frac{E\ dist}{R\ dist}$ = ____________

Part D. Place the fulcrum at one end of the meter stick. Attach the spring scale at the end. Place your resistance near the fulcrum.

	Masses	Force	Distance from fulcrum
Resistance	______	_____	____________________
Effort	______	_____	____________________
MA	$\frac{R}{E}$ = ____________		$\frac{\text{E dist}}{\text{R dist}}$ = ____________

Part E. Place the fulcrum at one end, the resistance at the other, and the spring scale near the fulcrum.

	Masses	Force	Distance from fulcrum
Resistance	______	_____	____________________
Effort	______	_____	____________________
MA	$\frac{R}{E}$ = ____________		$\frac{\text{E dist}}{\text{R dist}}$ = ____________

Summary: What conclusion can you make about the MA >1. $= 1$. < 1?

Evaluation Sample
Grade 9
Physical Science S
Unit: Mechanics

SECTION I -- IDENTIFICATION

Directions: Write the letter corresponding to the simple machine on the list below that is illustrated by the object demonstrated.

____ 1.	A. Gear
____ 2.	B. Wheel and axle
____ 3.	C. Class I lever
____ 4.	D. Class II lever
____ 5.	E. Class III lever
____ 6.	
____ 7.	
____ 8.	
____ 9.	
____10.	

SECTION II -- DETERMINATION OF MA

Select A, B, or C as appropriate from the list below, to give the MA of each of the following conditions.

A. The MA is greater than one.
B. The MA is less than one.
C. The MA is equal to one.

____ 1. The application of force to a machine results in the output of much greater speed.

____ 2. A block and tackle is used to lower a boat into the water.

____ 3. A driven gear has 10 teeth and a driving gear has 50 teeth.

____ 4. A single movable pulley is used to raise a 400 lb. load.

____ 5. A bucket of water is raised from a well by means of an axle with a 2 in. radius and a crank handle 5 in. long.

____ 6. A driving wheel of 6 in. diameter is connected by a belt to a driven wheel of 6 in. diameter.

____ 7. A third class lever is used to raise a 6 lb. load 4 ft. with a 30 lb. effort.

____ 8. A single fixed pulley is used to raise a two ton load.

____ 9. A second class lever is used to lift a 500 lb. load with a 40 lb. effort.

____10. A first class lever is used to lift 600 lbs. with 30 lbs. of effort.

SECTION III -- MULTIPLE CHOICE. Choose the best answer.

____ 1. The product of the resistance and the distance through which the resistance is moved is called the (A) work input (B) law of machines (C) effort (D) work output.

____ 2. When 30 newtons of force of effort are applied to a machine with a mechanical advantage of 3, the machine produces a force of (A) 30 nt (B) 10 nt (C) 15 nt (D) 90 nt.

____ 3. The ideal mechanical advantage refers to a machine that (A) produces large amounts of friction (B) always increases the force (C) is easy to build (D) has no friction.

____ 4. To reverse directions without changing force, use a (A) fixed pulley (B) block and tackle (C) wheel and axle (D) Class II lever.

____ 5. Energy is best described as (A) push (B) work (C) a force (D) ability to do work.

____ 6. A man uses a lever having a mechanical advantage of 4 to move a 600 lb. mass. The effort applied by the man is (A) increased 4 times (B) decreased 4 times (C) increased by 1/4 (D) decreased by 1/4.

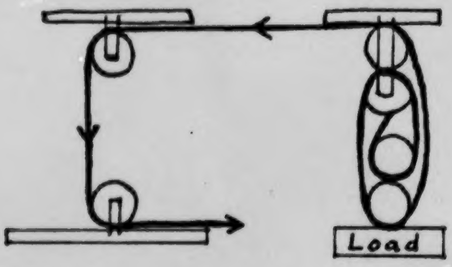
____ 7. When a row of six metal balls is struck by another metal ball, the energy of the moving ball is (A) transferred (B) transformed (C) lost (D) accelerated.

____ 8. Machines may be used to do any of the following except (A) reduce work (B) change the direction (C) gain speed (D) gain force.

____ 9. A man using an effort of 60 lbs. can lift which of the following weights, assuming the length of his arm from his elbow to his hand is 15 inches and the effort he uses is located 5 inches from his elbow? (A) 10 lbs. (B) 5 lbs. (C) 20 lbs. (D) 15 lbs.

____10. The unit of measure for energy in the metric system is (A) watt (B) joule (C) weight (D) kinetic.

____11. The diagram showing a system of pulleys has an MA of (A) 4 (B) 5 (C) 1 (D) 2.



____12. Which of the following is a correct expression for acceleration? (A) meters^2/sec. (B) meters/second (C) miles/hour (D) meters/sec^2

SECTION IV -- INCREASES, DECREASES, REMAINS THE SAME (I, D, RTS)

____ 1. As the MA of a simple machine decreases, the force ____.

____ 2. As the circumference of a driving gear decreases, the MA ____.

____ 3. As the load placed in a wheelbarrow increases, the MA ____.

____ 4. As the MA of a simple machine increases, the speed ____.

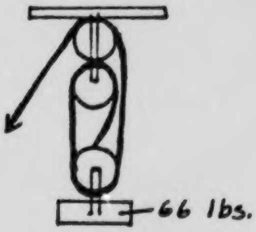
____ 5. As the direction of a fixed pulley changes, the MA ____.

SECTION V -- PROBLEMS. Use the four-step method. Show work!!!!

1. A man pushes a 20 kg box for 8 m using a force of 196 nt. (A) How much work does he do? (B) It takes 5 sec to perform this work. How much power does he have?

(A) ______________ (B) ______________

2. Find the MA and the effort required to lift the resistance, ignoring friction.



MA = ____________

E = ____________

3. A man was driving a car and came to a hill. He shifted the car into low, changing the driven gear to one containing 550 teeth, while the driving gear had 110 teeth. Find the MA and state whether or not the shifting caused the car to have an increase in force or an increase in speed.

MA = __________ __________________

4. A 200 newton object is lifted in a wheelbarrow with an effort 3 meters from the fulcrum. The load is 2 meters from the effort. Compute the effort.

E = _______________

EXTRA CHALLENGE. SHOW WORK.

A teenage girl weighing 120 lbs. sitting 5 ft. from the fulcrum of a see-saw balances two young girls on the other side. One of the smaller girls weighs 60 lbs. and sits 6 ft. from the fulcrum, and the other child sits 3 ft. from the fulcrum on the same side. How much does the child weigh?

____

BONUS -- DO ONLY ONE (3 pts. each)

A. Work as defined scientifically is done when a force is applied to an object and it moves in the same direction as the force. When studying work done with levers, an object moves up or down but the distance measured is horizontal. Explain why the horizontal distance can be measured and used to find work.

B. A boy weighing 125 lbs. runs up a flight of stairs in 10 seconds. The vertical height of the stairs is 11 ft. What is his horsepower?

Unit Outline
Grades 10, 11, 12
Biology: Descriptive
Unit: Ecology and the
Biosphere

I. Population Biology

  A. Population growth
    1. Population size
    2. Biotic potential
    3. Mortality
    4. Carrying capacity
  B. Environmental resistance
    1. Space
    2. Predation
    3. Parasitism and disease
    4. Interspecific and intraspecific competition

II. Ecosystem

  A. Biotic factors
    1. Food chains
    2. Pyramids of numbers and biomass
    3. Recycling materials
    4. Commensalism
    5. Mutualism
    6. Parasitism
  B. Abiotic factors
    1. Medium
    2. Soil
    3. Temperature
    4. Light
    5. Water

III. Human Interactions With the Environment

  A. Pollution
    1. Insecticides
    2. Biological control mechanisms
    3. Air pollutants
    4. Water pollutants
  B. Conservation of resources
    1. Food
    2. Soil
    3. Fuels
    4. Wildlife and forests
  C. Human population
    1. Rate of increase
    2. Discoveries, now and in the future

OBJECTIVE: To monitor the growth of a yeast population using appropriate sampling techniques and to enumerate the factors that affect growth

TITLE: "A Yeast Population Study"

SOURCE: Kaskel, et al. Laboratory Biology: Investigating Living Systems. Charles E. Merrill, 1976, pp. 333-338.

OBJECTIVE: To measure one important abiotic factor of an aquatic medium

TITLE: "Oxygen Availability in Water"

SOURCE: Kaskel, et al. Laboratory Biology: Investigating Living Systems. Charles E. Merrill, 1976, pp. 339-342.

OBJECTIVE: To measure several abiotic factors of a soil medium

TITLE: "Soil Chemistry"

SOURCE: Kaskel, et al. Laboratory Biology: Investigating Living Systems. Charles E. Merrill, 1976, pp. 343-346.

OBJECTIVE: To determine the effect of thermal pollution on dissolved oxygen and to infer the impact of this effect on the aquatic community

TITLE: "Thermal Pollution"

SOURCE: Kaskel, et al. Laboratory Biology: Investigating Living Systems. Charles E. Merrill, 1976, pp. 363-370.

OBJECTIVE: To determine the types of plants that occur in areas of varying light intensity

TITLE: "Project 2-3"

SOURCE: Blaustein, et al. Investigating Ecology. Arco Publishing Co., 1978, pp. 40-42.

OBJECTIVE: To design an experiment that will answer a meaningful question about ecological relationships involving oxygen

TITLE: "Designing Your Own Investigation"

SOURCE: Kaskel, et al. Laboratory Biology: Investigating Living Systems. Charles E. Merrill, 1976, p. 371.

OBJECTIVE: To sample a microarthropod population, identify the number of organisms of each order present, and relate this to various abiotic factors

TITLE: "Microarthropod Populations in Leaf Litter"

SOURCE: Hummer, et al. Probing Levels of Life. Charles E. Merrill, 1976, pp. 192-195.

OBJECTIVE: To compare and analyze the relationship of physical factors to organisms present

TITLE: "Field Studies of a Freshwater Ecosystem"

SOURCE: Hummer, et al. Probing Levels of Life. Charles E. Merrill, 1976, pp. 201-206.

OBJECTIVE: To observe and record the population fluctuations of two organisms in a predator-prey relationship (Paramecium and Didinium)

TITLE: "Project 4-6"

SOURCE: Blaustein, et al. Investigating Ecology. Arco Publishing Co., 1978, pp. 76-77.

Resources
Grades 10, 11, 12
Biology: Descriptive
Unit: Ecology and the
Biosphere

Text Materials

Blaustein, Elliott H., and Blaustein, Rose. *Investigating Ecology*. Arco Publishing Company, 1978.

Hummer, Paul J., Jr.; Kaskel, Albert; Kennedy, James E.; and Oram, Raymond F. *Probing Levels of Life*. Charles E. Merrill Publishing Co., 1976.

Kaskel, Albert; Hummer, Paul J., Jr.; Kennedy, James E.; and Oram, Raymond F. *Laboratory Biology: Investigating Living Systems*. Charles E. Merrill Publishing Co., 1976.

Oram, Robert F. *Biology: Living Systems*. Charles E. Merrill Publishing Co., 1976.

Otto, James H.; Towle, Albert; and Crider, Elizabeth H. *Biology Investigations*. Holt, Rinehart, and Winston, Inc., 1969.

Films

Ecology Checks and Balances -- Westerville Public Library

Let No Man Regret -- Westerville Public Library

Nature's Half Acre -- Columbus Public Library

Pesticides in Focus -- Shell Oil Company

The River Must Live -- Shell Oil Company

What Is Ecology? -- Columbus Public Library

Filmstrips -- High School Learning Center

Ecology at Work: The Case of the Bighorn Sheep

Ecology: Understanding the Crises

Sound Slides -- High School Learning Center

Biological Catastrophes: When Nature Becomes Unbalanced

Land Lab

Exemplary Activity
Grades 10, 11, 12
Biology: Descriptive
Unit: Ecology and the
Biosphere

Reference:

Kaskel, Albert; Hummer, Paul J., Jr.; Kennedy, James E.; and Oram, Raymond F. "Thermal Pollution," pp. 363-370, "Designing Your Own Investigation," p. 371, Laboratory Biology: Investigating Living Systems. Charles E. Merrill Publishing Co., 1976.

Evaluation Sample
Grades 10, 11, 12
Biology: Descriptive
Unit: Ecology and the
Biosphere

Reference:

Oram, Raymond F., and Kaskel, Albert. Evaluation Program for Biology: Living Systems. Charles E. Merrill Publishing Co., 1976, Chapters 26, 27, 30.

Unit Outline
Grades 10, 11, 12
Biology: Descriptive
Unit: Diversity Among
Living Things --
Classification of
Protista, Plants,
and Animals

I. Theories of Classification

    A. Aristotle
    B. Linnaeus
    C. Homologous structures

II. System of Classification

    A. Binomial nomenclature
    B. Groups of classification

III. Characteristics of Protists

    A. Algae
    B. Fungi
    C. Protozoa
    D. Bacteria
    E. Viruses

IV. Characteristics of Plants

    A. Nonvascular plants
    B. Vascular plants
        1. Ferns
        2. Gymnosperms
        3. Angiosperms

V. Characteristics of Animals

    A. Invertebrates
        1. Sponges
        2. Coelenterates
        3. Flatworms
        4. Roundworms
        5. Segmented worms
        6. Arthropods
        7. Echinoderms
    B. Vertebrates
        1. Sharks and rays
        2. Fish
        3. Amphibians
        4. Reptiles
        5. Birds
        6. Mammals

OBJECTIVE: To enumerate the diversity among protozoans and to apply the techniques for culturing them

TITLE: "Unicellular Organisms -- The Protozoans"

SOURCE: Otto, et al. Biology Investigations. Holt, Rinehart, and Winston, Inc., 1969, pp. 135-141.

OBJECTIVE: To identify the characteristics of a variety of molds, macroscopically and microscopically, and list the conditions required for mold growth

TITLE: "Mold Growth"

SOURCE: Kaskel, et al. Laboratory Biology: Investigating Living Systems. Charles E. Merrill Publishing Co., 1976, pp. 219-222.

OBJECTIVE: To identify the structures of the protonema, mature gametophyte, and sporophyte of mosses

TITLE: "Morphology of Mosses"

SOURCE: Hummer, et al. Probing Levels of Life. Charles E. Merrill Publishing Co., 1976, pp. 117-118.

OBJECTIVE: To identify the structures of the filament, prothallium, and sporophyte of ferns

TITLE: "Morphology of Ferns"

SOURCE: Hummer, et al. Probing Levels of Life. Charles E. Merrill Publishing Co., 1976, pp. 119-120.

OBJECTIVE: To enumerate the characteristics of two categories of stems of vascular plants

TITLE: "Internal Stem Anatomy"

SOURCE: Hummer, et al. Probing Levels of Life. Charles E. Merrill Publishing Co., 1976, pp. 121-122.

OBJECTIVE: To describe the characteristics used to separate the invertebrates into their respective phyla

TITLE: "Diversity of Invertebrates"

SOURCE: Hummer, et al. Probing Levels of Life. Charles E. Merrill Publishing Co., 1976, pp. 127-128.

OBJECTIVE: To describe the characteristics used to separate the vertebrates into their respective classes

TITLE: "Diversity of Vertebrates"

SOURCE: Hummer, et al. Probing Levels of Life. Charles E. Merrill Publishing Co., 1976, pp. 129-130.

OBJECTIVE: To apply the principles of classification in grouping organisms

TITLE: "Animal Classification"

SOURCE: Teacher developed

Resources
Grades 10, 11, 12
Biology: Descriptive
Unit: Diversity Among
Living Things --
Classification of
Protista, Plants,
and Animals

Text Materials

Hummer, Paul J., Jr.; Kaskel, Albert; Kennedy, James E.; and Oram, Raymond F. Probing Levels of Life. Charles E. Merrill Publishing Co., 1976.

Kaskel, Albert; Hummer, Paul J., Jr.; Kennedy, James E.; and Oram, Raymond F. Laboratory Biology: Investigating Living Systems. Charles E. Merrill Publishing Co., 1976.

Oram, Robert F. Biology: Living Systems. Charles E. Merrill Publishing Co., 1976.

Otto, James H.; Towle, Albert; and Crider, Elizabeth H. Biology Investigations. Holt, Rinehart, and Winston, Inc., 1969.

Films

Amphibians and Reptiles -- Columbus Public Library

Bacteria -- Columbus Public Library

Rival Worlds -- Shell Oil Company

Say Goodbye -- Westerville Public Library

Segmentation: The Annelids -- Columbus Public Library

Single Cell Animals -- Columbus Public Library

Spiders -- Columbus Public Library

Unseen Enemies (protists) -- Shell Oil Company

What Is a Bird? -- Columbus Public Library

What Is a Mammal? -- Columbus Public Library

What Is an Amphibian? -- Columbus Public Library

Sound Filmstrips -- High School Learning Center

The Plants

The Protists

Exemplary Activity
Grades 10, 11, 12
Biology: Descriptive
Unit: Diversity Among
Living Things --
Classification of
Protista, Plants,
and Animals

OBJECTIVE: To apply the principles of classification in grouping organisms

MATERIALS AND EQUIPMENT: See Procedure

PROCEDURE:

1. Look through the magazines given to your group to find eight (8) organisms that belong to different phyla or classes.

2. Give a written description of each organism and where it would be found (environment).

3. Make a chart for each organism as follows.

   A. Name of organism

      1. Phyla to which it belongs and description of phyla

      2. Class to which it belongs and description of class

      3. Order to which it belongs and description of order

      4. Other organism that would be classified with it

Evaluation Sample
Grades 10, 11, 12
Biology: Descriptive
Unit: Diversity Among
Living Things --
Classification of
Protista, Plants,
and Animals

Reference:

Oram, Raymond F., and Kaskel, Albert. Evaluation Program for Biology: Living Systems. Charles E. Merrill Publishing Co., 1976, Chapters 15, 16, 17, 18.

Unit Outline
Grades 10, 11, 12
Biology: Descriptive
Unit: Within the Organism --
Anatomy and Physiology

I. Digestion

- A. Selected plants and protists
    - 1. Autotrophs
    - 2. Heterotrophs
- B. Selected animals
    - 1. One body opening
    - 2. Two body openings
- C. Human

II. Transport

- A. Plants
    - 1. Osmosis
    - 2. Transpiration
    - 3. Cohesion-tension theory
- B. Selected animals
    - 1. Open circulatory system
    - 2. Closed circulatory system
    - 3. Blood
    - 4. Immune system

III. Respiration

- A. Gas exchange in plants
- B. Gas exchange in animals
    - 1. Skin and gills
    - 2. Tracheal system
    - 3. Lung system

IV. Waste Removal

- A. Plant metabolism versus animal metabolism
- B. Selected animals
- C. Humans

V. Support and Locomotion

- A. Skeletal systems
    - 1. Exoskeleton
    - 2. Endoskeleton
- B. Locomotion
    - 1. Protists and simple animals
    - 2. Insects
    - 3. Vertebrates

Unit Outline (Cont.)
Grades 10, 11, 12
Biology: Descriptive
Unit: Within the Organism --
Anatomy and Physiology

VI. Chemical Control Systems

  A. Selected plants
    1. Tropisms
    2. Auxins
  B. Selected animals
    1. Metamorphosis
    2. Molting
  C. Humans

VII. Nervous Control Systems

  A. Invertebrates
  B. Vertebrates
  C. Humans

VIII. Behavior

  A. Plants
  B. Animals
    1. Innate
    2. Reflex
    3. Instinct
    4. Learned behavior
    5. Social behavior

Suggested Activities
Grades 10, 11, 12
Biology: Descriptive
Unit: Within the Organism --
Anatomy and Physiology

OBJECTIVE: To identify the major organs of a pig's digestive system and compare the system to that of a human

TITLE: "Pig Digestive System"

SOURCE: Kaskel, et al. Laboratory Biology: Investigating Living Systems. Charles E. Merrill Publishing Co., 1976, pp. 261-266.

OBJECTIVE: To formulate and test a hypothesis relating plant transpiration rate to selected environmental conditions

TITLE: "Plant Transpiration"

SOURCE: Kaskel, et al. Laboratory Biology: Investigating Living Systems. Charles E. Merrill Publishing Co., 1976, pp. 267-271.

OBJECTIVE: To locate and identify the ingestive and digestive organs of a hydra and a planarian

TITLE: "Ingestion and Digestion in Hydras and Planaria"

SOURCE: Hummer, et al. Probing Levels of Life. Charles E. Merrill Publishing Co., 1976, pp. 133-134.

OBJECTIVE: To formulate and test a hypothesis relating oxygen intake to different environmental conditions

TITLE: "Oxygen Intake by an Animal"

SOURCE: Kaskel, et al. Laboratory Biology: Investigating Living Systems. Charles E. Merrill Publishing Co., 1976, pp. 287-290.

OBJECTIVE: To compare the amounts of carbon dioxide produced by muscle tissue during different activities, and to explain how CO_2 production can be used as an indicator of muscle activity

TITLE: "Measuring Differences in Muscular Activity"

SOURCE: Kaskel, et al. Laboratory Biology: Investigating Living Systems. Charles E. Merrill Publishing Co., 1976, pp. 299-303.

OBJECTIVE: To observe the effect of gibberellic acid on plant growth

TITLE: "Influence of Giberellic Acid on Plant Growth"

SOURCE: Kaskel, et al. Laboratory Biology: Investigating Living Systems. Charles E. Merrill Publishing Co., 1976, pp. 303-306.

OBJECTIVE: To observe and record growth patterns of roots and stems as they emerge from germinating seeds

TITLE: "Plant Tropisms"

SOURCE: Kaskel, et al. Laboratory Biology: Investigating Living Systems. Charles E. Merrill Publishing Co., 1976, pp. 319-322.

OBJECTIVE: To illustrate the earthworm's unlearned response to light and gravity

TITLE: "Earthworm Behavior"

SOURCE: Kaskel, et al. Laboratory Biology: Investigating Living Systems. Charles E. Merrill Publishing Co., 1976, pp. 327-332.

OBJECTIVE: To locate and identify an arteriole, a capillary, and a venule; to determine the effect of selected substances on blood vessel diameter

TITLE: "Capillary Circulation"

SOURCE: Hummer, et al. Probing Levels of Life. Charles E. Merrill Publishing Co., 1976, pp. 142-143.

OBJECTIVE: To investigate the recovery time of human pulse and breathing rate after strain as an example of homeostasis

TITLE: "The Biggest Put-On in Life"

SOURCE: Wong, Harry K., and Dolmatz, M.S. IIS -- Homeostasis. Prentice-Hall, 1971, pp. 181-186.

OBJECTIVE: To observe the reactions of hydra to various stimuli

TITLE: "Behavior of Hydra"

SOURCE: Teacher developed

Resources
Grades 10, 11, 12
Biology: Descriptive
Unit: Within the Organism --
Anatomy and Physiology

Text Materials

Hummer, Paul J., Jr.; Kaskel, Albert; Kennedy, James E.; and Oram, Raymond F. Probing Levels of Life. Charles E. Merrill Publishing Co., 1976.

Kaskel, Albert; Hummer, Paul J., Jr.; Kennedy, James E.; and Oram, Raymond F. Laboratory Biology: Investigating Living Systems. Charles E. Merrill Publishing Co., 1976.

Oram, Robert F. Biology: Living Systems. Charles E. Merrill Publishing Co., 1976.

Otto, James H.; Towle, Albert; and Crider, Elizabeth H. Biology Investigations. Holt, Rinehart, and Winston, Inc., 1969.

Wong, Harry K., and Dolmatz, M.S. IIS -- Homeostasis. Prentice-Hall, 1971.

Films

Cousteau's Seals -- Westerville Public Library

Cousteau's Whales -- Westerville Public Library

Human Circulation -- Columbus Public Library

Man: The Incredible Machine -- Westerville Public Library

Mysteries of Animal Behavior -- Westerville Public Library

Strange Creatures of the Night -- Westerville Public Library

Sound Filmstrips -- High School Learning Center

Biological Societies

Film Loops -- High School Learning Center

Cheek Epithelium Cells

Earthworm, Part 2

Earthworm, Part 3

The Frog: Anatomy of the Central Nervous System

The Frog: Circulation -- the Veins

Frog: General Dissection

The Frog, Part 3, Opening Body Cavity

The Frog, Part 4, Internal, Digestive, and Respiratory Organs

The Frog: Reproductive and Urinary Systems of the Male and Female

Osmosis: Dialysis

Phototropic Responses in Coleoptiles

Primary Growth in Trees

Smear and Squash Techniques

Transpiration: Water Loss in the Leaf

Sound Slides -- High School Learning Center

Bioclocks: Understanding the Rhythms of Life, Parts I and II

Exemplary Activity
Grades 10, 11, 12
Biology: Descriptive
Unit: Within the Organism --
Anatomy and Physiology

OBJECTIVE: To observe the reactions of hydra to various stimuli

MATERIALS AND EQUIPMENT: See Procedure

INTRODUCTION:

The conditions in an organism's environment are seldom, if ever, constant. Temperatures change; the availability of food, water, and oxygen varies; and predators increase and decrease in number. Changes in the environment may constitute a stress to the organism. If the organism is to maintain itself and survive, it must respond to changes, and adjustments must be made to overcome the stress. In this investigation, you will study the reactions of the hydra to various stimuli. In recording observations, one should be cautious of interpreting the hydra's responses as having a conscious purpose.

PROCEDURE:

1. Place a few green hydras in some water in a petri dish. Observe them with a dissecting microscope; note general form and features. Identify: mouth, tentacles, and base. Observe methods of locomotion.

2. With a probe, touch a hydra at different points, such as tentacles, "body," and base. Record observations.

3. Direct a beam of light onto one of the organisms. Observe for a reaction. Record observation.

4. Place a couple of drops of vinegar in the water beside a hydra. Observe the tentacles carefully as this is done. Record observations.

5. Place a few pieces of tropical fish food in the water with the hydra. Record observation.

Questions

1. Describe methods of locomotion you observed.

2. What is the significance of the hydra's reaction to being touched with a probe?

3. What purpose do the tentacles seem to serve?

4. Is the behavior of the hydra nonpurposeful or purposeful? Explain.

Evaluation Sample
Grades 10, 11, 12
Biology: Descriptive
Unit: Within the Organism --
Anatomy and Physiology

Reference:

Oram, Robert F., and Kaskel, Albert. Evaluation Program for Biology: Living Systems. Charles E. Merrill Publishing Co., 1976, Chapters 19-25.

Unit Outline
Grades 10, 11, 12
Biology: Descriptive
Unit: Energy and Life --
Photosynthesis and
Respiration

I. Cell Theory and Structure

- A. Historical development of cell theory
- B. Levels of organization
- C. Cellular membranes
    - 1. Diffusion
    - 2. Osmosis
    - 3. Factors affecting permeability
    - 4. Passive and active transport
    - 5. Phagocytosis
- D. Organelles
- E. Nucleus
- F. Activities of protoplasm
    - 1. Basic organic compounds
    - 2. Metabolism
    - 3. Anabolism

II. Photosynthesis

- A. Chlorophyll and chloroplasts
- B. ATP
- C. Light reaction
- D. Dark reaction

III. Respiration

- A. Activation energy
- B. Enzymes and coenzymes
- C. Cellular respiration
    - 1. Aerobic
    - 2. Anaerobic -- fermentation

Suggested Activities
Grades 10, 11, 12
Biology: Descriptive
Unit: Energy and Life -- Photosynthesis and Respiration

OBJECTIVE: To observe the basic structure of plant and animal cells and enumerate the similarities and differences

TITLE: "The Basic Unit of Life (Parts I and II)"

SOURCE: Kaskel, Hummer, et al. Laboratory Biology: Investigating Living Systems. Charles E. Merrill, 1976, pp. 47-56.

OBJECTIVE: To determine the effect of two factors on diffusion rate

TITLE: "Factors Influencing Diffusion"

SOURCE: Kaskel, Hummer, et al. Laboratory Biology: Investigating Living Systems. Charles E. Merrill, 1976, pp. 59-61.

OBJECTIVE: To observe the effect of an enzyme on chemical reaction rate and use a model to explain observations

TITLE: "Chemical Nature of Enzymes"

SOURCE: Kaskel, Hummer, et al. Laboratory Biology: Investigating Living Systems. Charles E. Merrill, 1976, pp. 67-70.

OBJECTIVE: To determine the effect of three factors on enzymatic action

TITLE: "Characteristics of Enzymes"

SOURCE: Kaskel, Hummer, et al. Laboratory Biology: Investigating Living Systems. Charles E. Merrill, 1976, pp. 71-76.

OBJECTIVE: To measure and record fermentation rates under varying conditions and apply reaction principles to explain the observations

TITLE: "Factors Influencing Rate of Yeast Respiration"

SOURCE: Kaskel, Hummer, et al. Laboratory Biology: Investigating Living Systems. Charles E. Merrill, 1976, pp. 77-80.

OBJECTIVE: To determine the role of light in photosynthesis and analyze the effect of varying light intensity on photosynthetic rate

TITLE: "Some Aspects of Photosynthesis"

SOURCE: Hummer, Kaskel, et al. Probing Levels of Life. Charles E. Merrill, 1976.

OBJECTIVE: To use a constant-pressure respirometer to determine the effect of varying temperatures on the oxygen consumption of a land snail

TITLE: "Using a Manometer"

SOURCE: Merholt, et al. A Sourcebook for the Biological Sciences. Harcourt, Brace and World, 1966, p. 284.

Resources
Grades 10, 11, 12
Biology: Descriptive
Unit: Energy and Life -- Photosynthesis and Respiration

Text Materials

Hummer, Paul J., Jr.; Kaskel, Albert; Kennedy, James E.; and Oram, Raymond F. Probing Levels of Life. Charles E. Merrill Publishing Co., 1976.

Kaskel, Albert; Hummer, Paul J., Jr.; Kennedy, James E.; and Oram, Raymond F. Laboratory Biology: Investigating Living Systems. Charles E. Merrill Publishing Co., 1976.

Morholt, Evelyn; Brandwein, Paul F.; and Joseph, Alexander. A Sourcebook for the Biological Sciences. Harcourt, Brace and World, 1966.

Oram, Robert F. Biology: Living Systems. Charles E. Merrill Publishing Co., 1976.

Otto, James H.; Towle, Albert; and Crider, Elizabeth H. Biology Investigations. Holt, Rinehart and Winston, 1969.

Films -- Columbus Public Library

How the Body Uses Energy

Plant Motions -- Roots, Stems, Leaves

The Role of the Green Plant

Filmstrips -- High School Learning Center

Introduction to Photosynthesis

Material Cycles in Nature

Nutritional Relations in Nature

Film Loops -- High School Learning Center

Elodea Leaf Cells

Enzyme Action: Catalase

Photosynthesis: Pigments

Film Loops (Cont.)

Respiration: Aerobic Respiration

Transpiration: Water Loss in the Leaf

Sound Filmstrips -- High School Learning Center

Amino Acid Structure and the Peptide Link

Introduction to Biological Oxidation and ATP

Introduction to Photosynthesis

Introduction to the Carbon Cycle

Exemplary Activity
Grades 10, 11, 12
Biology: Descriptive
Unit: Energy and Life --
Photosynthesis and
Respiration

Reference:

Kaskel, Albert; Hummer, Paul J., Jr.; Kennedy, James E.; and Oram, Raymond F. "Factors Influencing Rate of Yeast Respiration," Laboratory Biology: Investigating Living Systems. Charles E. Merrill Publishing Co., 1976, pp. 77-80.

Evaluation Sample
Grades 10, 11, 12
Biology: Descriptive
Unit: Energy and Life -- Photosynthesis and Respiration

Multiple Choice

____ 1. Breakdown of large organic molecules into smaller ones suitable for cell use is (A) respiration (B) secretion (C) digestion (D) excretion.

____ 2. Formation of chemical molecules by certain cells that influence other cell activities is (A) nutrition (B) secretion (C) excretion (D) absorption.

____ 3. In animal cells, the function of the ribosomes is (A) synthesis of protein molecules (B) production of pigments (C) breakdown of organic molecules (D) aiding in the destruction of bacteria.

____ 4. Structures for the formation and storage of color pigments in a plant cell are called (A) endoplasmic reticulum (B) vacuoles (C) ribosomes (D) plastids.

____ 5. The chemical compound that gives strength to soft cell walls is (A) lipids (B) cellulose (C) starch (D) protein.

____ 6. Which of the following represents the highest degree of certainty and will remain unchanged? (A) hypothesis (B) conclusion (C) law (D) theory (E) fact

____ 7. The specific chemical molecule in which energy is stored in living cells is (A) RNA (B) glucose (C) DNA (D) starch (E) ATP.

____ 8. Which of the following would normally diffuse most slowly through a cell membrane? (A) starch (B) carbon dioxide (C) glucose (D) water

____ 9. The one differing factor between a control group and an experimental group is the (A) response (B) variable (C) stimulus (D) variation (E) mutation.

____10. Diffusion of one substance through another is affected by several activities. By which of the following would it be increased? (A) decreasing external pressures (B) shaking (C) making particles larger (D) freezing

____11. Which of the following is a true compound? (A) air (B) sugar (C) hydrogen (D) iron

____12. When starting to observe an object under the microscope, which structures would you use? (A) eyepiece, fine adjustment, 43x objective (B) eyepiece, fine adjustment, 10x objective (C) eyepiece, coarse adjustment, 43x objective (D) eyepiece, coarse adjustment, 10x objective

____13. The metric prefix meaning 1000 X is (A) centi (B) milli (C) kilo (D) deci (E) micron.

____14. How would carbon dioxide probably be released from the cell of an ameba? (A) osmosis (B) diffusion (C) absorption (D) respiration

____15. The spreading of the cytoplasm of a cell of Elodea leaf placed in distilled water is due to (A) the increase in cytoplasmic concentration of the salt due to the loss of water from the cell (B) an increase in the rate of entry of water molecules through the cell wall from the external solution (C) the lower concentration of water outside the cell membrane than within the cytoplasm (D) the change of the colloid to a solution in the cytoplasm caused by the increased solvent in the cytoplasm.

____16. The electron microscope magnifies up to (A) 20 times (B) 200 times (C) 2,000 times (D) 200,000 times.

____17. The smaller units of which the proteins are made are ___?___ molecules. (A) amino acids (B) glucose (C) glycerol (D) glycogen

____18. The rigid condition of soft plant cells resulting from a hypotonic condition is (A) plasmolysis (B) cyclosis (C) pinocytosis (D) turgor.

____19. The first part of the cell theory was proposed by (A) Hooke and Virchow (B) Dujardin and Schwann (C) Schleiden and Virchow (D) Schleiden and Schwann.

____20. The engulfing process by which large molecules enter cells is (A) plasmolysis (B) diffusion (C) osmosis (D) pinocytosis (E) cytolysis.

____21. The chemical activity of an atom is determined by the number and arrangement of its (A) protons (B) nucleus (C) neutrons (D) electrons.

____22. If an electrically neutral atom has 8 electrons and 10 neutrons, the atomic number is (A) 2 (B) 8 (C) 10 (D) 18.

____23. If the atom in number 22 were to combine with an atom having 20 electrons and 20 neutrons, its formula would be (A) XY (B) X_2Y (C) X_2Y_2 (D) XY_2.

True or False

____24. The maximum number of electrons found in the first energy level is two.

____25. The plasma membrane of a cell consists of two layers of lipids and one layer of protein.

____26. The diaphram is the structure on the microscope by which you increase or decrease magnification.

____27. If the temperature on the Celsius scale is 20 degrees, the Fahrenheit temperature would be 72 degrees.

____28. In using the microscope, the image appears to the right of the center in the field of vision. To center the image, you must move the slide to the left.

____29. An isotope is an atom of the same element with a different atomic mass.

____30. An organic compound must be composed of carbon and nitrogen.

____31. The atomic number of a certain element is 19. There should be one electron in its outer energy level.

____32. The branch of biology that deals with the study of the structures of living things is called physiology.

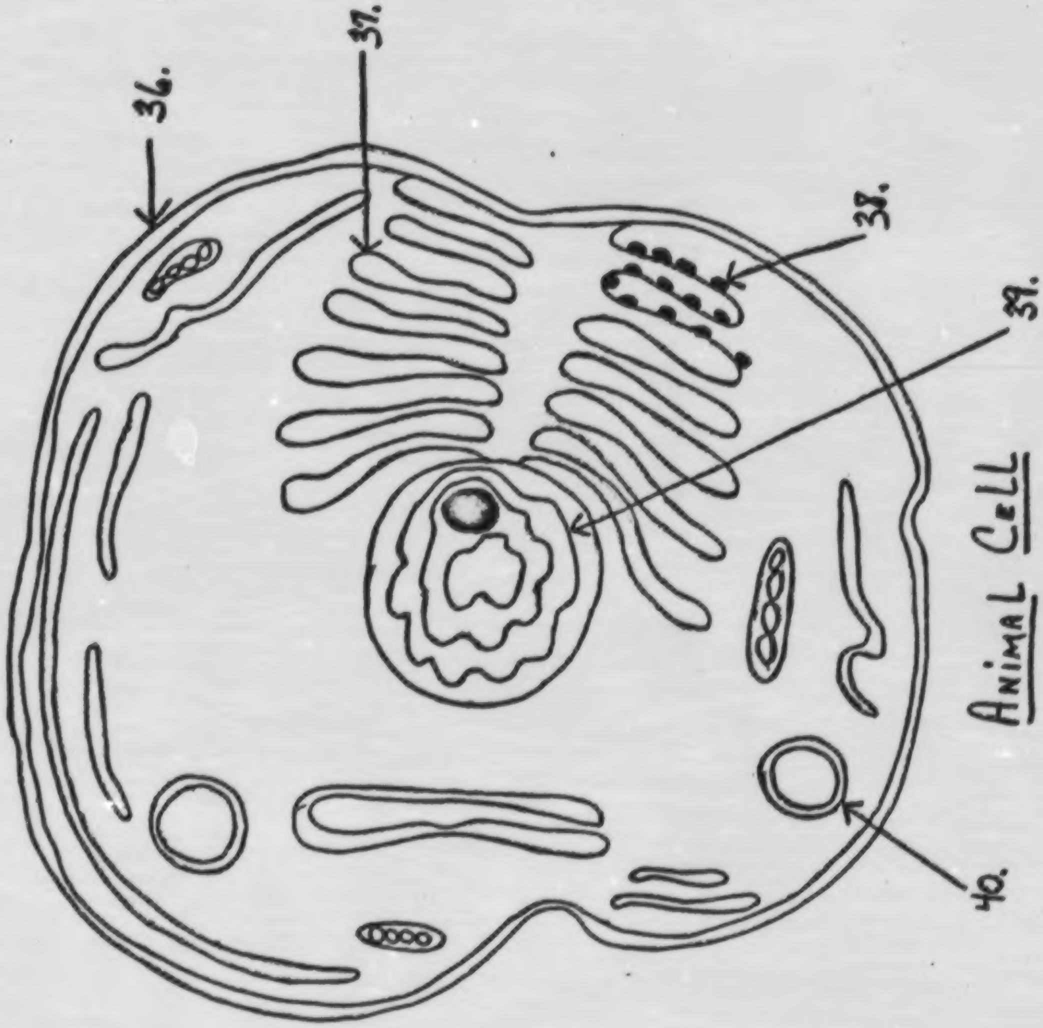
____33. A colloid is a transparent mixture composed of one type of molecule dispersed throughout another type of molecule.

IN ORDER TO GET CREDIT FOR THE FOLLOWING TWO QUESTIONS, THE ITEMS MUST BE ARRANGED IN THE PROPER ORDER -- SMALLEST TO LARGEST OR FIRST TO LAST.

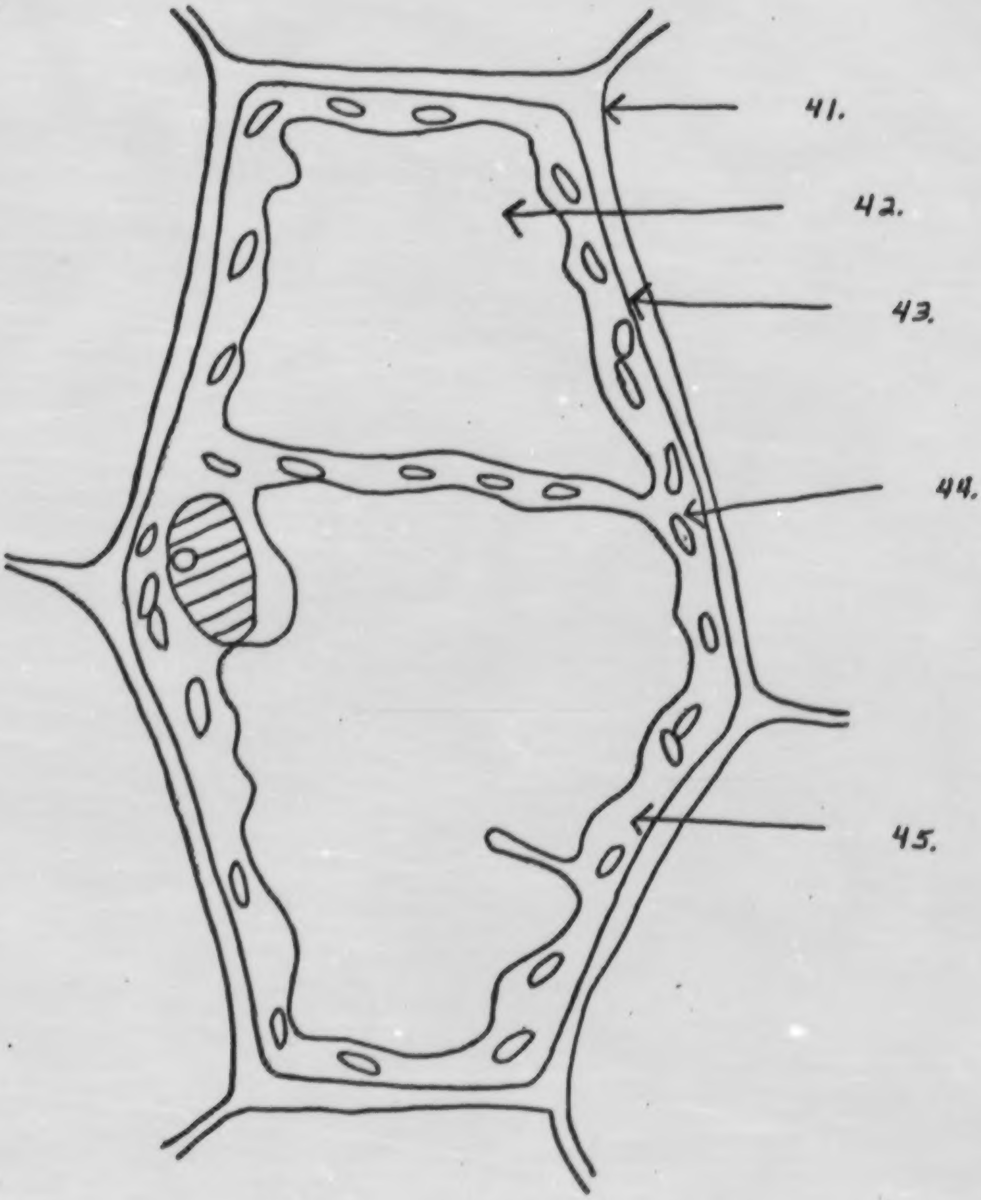
34. Organism, tissue, organ, cell, system

35. Gather information, conclusions, problem, observation, hypothesis, experimentation

36-40. Identify the indicated parts of the drawing.


36.
37.
38.
39.
40.
Animal Cell

41-45. Identify the indicated parts of the drawing.



PLANT CELL

Reference:

Oram, Raymond F., and Kaskel, Albert. Evaluation Program for Biology, Living Systems. Charles E. Merrill Publishing Co., 1976, Chapters 4, 5, 6.

Unit Outline
Grades 10, 11, 12
Biology: Descriptive
Unit: Continuity of Life -- Reproduction, Heredity, and Evolution

I. Reproduction: The Cell

  A. Life from life
    1. Spontaneous generation: prologue
    2. The debate continues
    3. Convincing evidence
  B. Cellular basis of reproduction
    1. Spontaneous generation: epilogue
    2. Interphase
    3. Mitosis
    4. Chromosome number
    5. Meiosis

II. Reproduction: The Organism

  A. Asexual reproduction
  B. Sexual reproduction
  C. Patterns of development

III. Heredity

  A. Origin of genetics
    1. Mendel's experiments
    2. Analysis
    3. The test
    4. Terminology
  B. Solving genetics problems
    1. Probability
    2. One trait
    3. Incomplete dominance
    4. Two traits
    5. Multiple alleles

IV. Genes and Chromosomes

  A. The chromosome theory of heredity
    1. Sex determination
    2. Morgan's discovery
    3. Nondisjunction
  B. New concepts in genetics
    1. Gene linkage and crossing over
    2. Many genes -- one effect
    3. Heredity and environment
    4. Human genetics
    5. Population genetics: the Hardy-Weinberg Principle

V. Reproduction: Chemical Aspects

- A. Experimental evidence
  1. Bacterial transformation
  2. Viruses and heredity
  3. A model -- DNA
  4. Replication of DNA
- B. The role of DNA
  1. Genes and proteins
  2. DNA code
  3. Protein synthesis
  4. Types of genes
  5. Mutation
  6. DNA outside the nucleus

VI. Evolution

- A. Evidence
  1. Fossil record
  2. Comparative anatomy
  3. Comparative embryology
  4. Experiments by Oparin, Miller, and Fox
- B. Explanations
  1. Lamarck
  2. Darwin
  3. Population genetics

VII. Adaptation and Speciation

- A. Evolution of adaptations
  1. Variations
  2. Natural selection
  3. Types of adaptations: morphological and physiological
  4. Industrial melanism: camouflage

OBJECTIVE: To demonstrate the interaction of the environment with the expression of a genetic characteristic

TITLE: "Influence of an Environmental Factor on Gene Action"

SOURCE: Otto, Towle, and Crider. Biology Investigations. Holt, Rinehart and Winston, Inc., 1969, p. 349.

OBJECTIVE: To examine the influence of environmental conditions on seed germination

TITLE: "Seed Adaptations".

SOURCE: Kaskel, Hummer, Kennedy, and Oram. Laboratory Biology: Investigating Living Systems. Charles E. Merrill Publishing Co., 1976.

OBJECTIVE: To acquaint students with the structural parts of the DNA and RNA molecules and their chemical organization

TITLE: "DNA and RNA"

SOURCE: Kaskel, Hummer, Kennedy, and Oram. Laboratory Biology: Investigating Living Systems. Charles E. Merrill Publishing Co., 1976.

OBJECTIVE: To show visually how a DNA molecule controls the development of a characteristic through the organization of a specific protein, and to relate the process of protein synthesis to mutations

TITLE: "RNA and Protein Building"

SOURCE: Kaskel, Hummer, Kennedy, and Oram. Laboratory Biology: Investigating Living Systems. Charles E. Merrill Publishing Co., 1976.

OBJECTIVE: To determine if life can arise spontaneously or if life must come from preexisting organisms

TITLE: "Growth Characteristics of Microorganisms"

SOURCE: Otto, Towle, and Crider. Biology Investigations. Holt, Rinehart and Winston, Inc., 1969.

OBJECTIVE: To observe and study changes occurring in a cell during mitosis; to identify stages of mitotic division and locate cells representing each of the stages

TITLE: "Mitosis"

SOURCE: Kaskel, Hummer, Kennedy, and Oram. Laboratory Biology: Investigating Living Systems. Charles E. Merrill Publishing Co., 1976.

OBJECTIVE: To determine the number of expected genotypes and phenotypes in 100 offspring, and to compare with the number of observed genotypes and phenotypes obtained by tossing coins 100 times

TITLE: "Genotype and Phenotype Numbers Using One Trait"

SOURCE: Kaskel, Hummer, Kennedy, and Oram. Laboratory Biology: Investigating Living Systems. Charles E. Merrill Publishing Co., 1976.

OBJECTIVE: To provide visual practice in the development of Mendel's principles of dominance, segregation, and unit characters

TITLE: "A Study of Mendelian Laws and Principles"

SOURCE: Otto, Towle, and Crider. Biology Investigations. Holt, Rinehart and Winston, Inc., 1969.

OBJECTIVE: To study incomplete dominance involving one pair of genes

TITLE: "Incomplete Dominance"

SOURCE: Otto, Towle, and Crider. Biology Investigations. Holt, Rinehart and Winston, Inc., 1969.

OBJECTIVE: To understand the technique used for determining blood type; to determine actual ratios obtained and compare with predicted ratios expected; and to relate blood types to multiple allele inheritance

TITLE: "Blood Type"

SOURCE: Kaskel, Hummer, Kennedy, and Oram. Laboratory Biology: Investigating Living Systems. Charles E. Merrill Publishing Co., 1976.

OBJECTIVE: To determine if a character is sex-linked, based upon the frequency of occurrence

TITLE: "Sex-Linked or Not Sex-Linked"

SOURCE: Kaskel, Hummer, Kennedy, and Oram. Laboratory Biology: Investigating Living Systems. Charles E. Merrill Publishing Co., 1976.

OBJECTIVE: To study the inheritance of sex-linked traits

TITLE: "Sex Chromosomes and Linkage"

SOURCE: Otto, Towle, and Crider. Biology Investigations. Holt, Rinehart and Winston, Inc., 1969.

OBJECTIVE: To sample a human population and determine the frequency of certain traits -- a practical application of the Hardy-Weinberg Principle

TITLE: "Frequency of Human Genetic Traits"

SOURCE: Otto, Towle, and Crider. Biology Investigations. Holt, Rinehart and Winston, Inc., 1969.

Resources
Grades 10, 11, 12
Biology: Descriptive
Unit: Continuity of Life -- Reproduction, Heredity, and Evolution

Text Materials

Biological Science, Molecules to Man, BSCS. Houghton-Mifflin Company, 1963, pp. 127-175, 329-425.

Hummer, Paul J., Jr.; Kaskel, Albert; Kennedy, James E.; and Oram, Raymond F. Probing Levels of Life. Charles E. Merrill Publishing Co., 1976.

Hutchins, Carleen Maley. Life's Key -- DNA. Coward-McCann, Inc., 1961.

Kaskel, Albert; Hummer, Paul J., Jr.; Kennedy, James E.; and Oram, Raymond F. Laboratory Biology: Investigating Living Systems. Charles E. Merrill Publishing Co., 1976.

Oram, Robert F. Biology: Living Systems. Charles E. Merrill, 1976, pp. 125-201.

Otto, James H.; Towle, Albert; and Crider, Elizabeth H. Biology Investigations. Holt, Rinehart and Winston, Inc., 1969.

Snyder, Laurence H. The Principles of Heredity. D.C. Heath and Company, 1951.

Films -- Columbus Public Library

Cell Reproduction

DNA -- Molecules of Heredity

Gene Action

Laws of Heredity

Meiosis

Filmstrips -- High School Biology Department

DNA -- A Key to All Life

DNA and Protein Synthesis

DNA -- Structure and Replication

Filmstrips (Cont.)

- Dominance
- Genetics and the Cell
- How Cells Divide
- Incomplete Dominance, Segregation, Punnett Square
- Independent Assortment
- Maturation of Gametes
- New Trait Combinations and Mutations
- Population Genetics

Transparencies -- High School Learning Center

- Contrasting Traits -- Garden Pea
- Dihybrid Cross
- DNA Molecule
- Hybrid Cross -- Guinea Pigs
- Incomplete Dominance -- Four O'Clocks
- Incomplete Dominance -- Shorthorn Cattle
- Inheritance of Sex -- Drosophilia
- Mendel's Law of Segregation
- Mitosis -- Animal Cell
- Mutations in Reproductive Cells of Drosophilia
- Spermatogenesis, Oogenesis, Fertilization

Exemplary Activity
Grades 10, 11, 12
Biology: Descriptive
Unit: Continuity of Life --
Reproduction, Heredity, and Evolution

References:

Kaskel, Albert; Hummer, Paul J., Jr.; Kennedy, James E.; and Oram, Raymond F. "Blood Type," Laboratory Biology: Investigating Living Systems. Charles E. Merrill Publishing Co., 1976, p. 125.

Ibid. "Mitosis," p. 105.

Evaluation Sample
Grades 10, 11, 12
Biology: Descriptive
Unit: Continuity of Life -- Reproduction, Heredity, and Evolution

Biology Unit, Chapters 13, 14, 15
Part I -- Multiple Choice

____ 1. The era that identifies the beginning of earth formation is the (A) Mesozoic (B) Cenozoic (C) Archeozoic (D) Paleozoic (E) Proterozoic.

____ 2. A change in a body characteristic of an organism is called a(an) (A) mutation (B) acquired characteristic (C) heredity change (D) maturation (E) variation.

____ 3. The theory of natural selection includes the concept of (A) inheritance of acquired characteristics (B) use and disuse (C) conservation of energy (D) survival of the fittest (E) selective breeding.

____ 4. Which of the following appendages are similar in function but differ in origin and structure? (A) front leg of dog and arm of man (B) wing of robin and wing of wren (C) wing of butterfly and wing of bat (D) flipper of whale and leg of cat (E) tail of monkey and tail of mouse

____ 5. The probable figure for the age of life on earth is about (A) 2 1/2 million years (B) 4 1/2 billion years (C) 2 billion years (D) 4 1/2 million years.

____ 6. Darwin believed that (A) evolution takes place by the action of mutations (B) man descended from the present-day apes (C) evolution comes about through the survival of the fittest (D) the idea of fixed species was valid (E) individuals of a given species vary little, if at all, in individual traits.

____ 7. The most important lack of information at Darwin's time was knowledge of (A) genetics (B) fossils (C) prehistoric climates (D) geographic distribution of animals.

____ 8. Which of the following is the best explanation for the fact that the animals in the White Sands Natural Monument are white? (A) Chemicals from the sand diffused into the animals making them white. (B) White animals were not captured by predators as often as dark animals. (C) The sun bleached all the coloring out of the animals until they were white. (D) The animals felt a need for the white color as a protective device.

Questions 9-12 are based on the following statements referring to ideas concerning evolution.

I. Many types of variations exist within any species.
II. Species tend to increase in a geometric ratio generation after generation.
III. Some variations have more survival value than do others.
IV. Although organisms have a tendency to increase in numbers, the population of a given species tends to remain constant.
V. There is a struggle for survival.
VI. Organisms adapt to their environment by inheriting variations that have been developed by their parents through use or disuse of certain structures.

____ 9. Statement V would be a logical conclusion from statements (A) I and II (B) II and III (C) II and IV (D) III and VI.

____10. Darwin did not agree with statement (A) I (B) II (C) III (D) VI.

____11. Malthus contrasted the limited food supply with statement (A) I (B) II (C) IV (D) V.

____12. According to Lamarck, statement I could be best explained by accepting statement (A) II (B) III (C) IV (D) VI.

____13. Who was the scientist to devise an experiment that disproved the theory of inheritance of acquired characteristics? (A) Weismann (B) Ray (C) Aristotle (D) Fox (E) Darwin

____14. On an island there are isolated populations of two types of frogs. Which of the following would be most important in empirically classifying these frogs? (A) They live in similar habitats. (B) They have a different appearance. (C) They have a common fossil ancestor. (D) They will interbreed and produce fertile offspring.

Part II -- True or False. Use T for true and F for false.

____15. The age of fossils in rock formations is determined by the rate of change of Carbon-14 to Carbon-12.

____16. The four gases believed to have made up the primitive atmosphere were carbon dioxide, methane, water vapor, and hydrogen.

____17. The time necessary for a given portion of a radioactive material to decay is called half-life.

____18. The evolution of many forms of life from a common ancestor is known as adaptive radiation.

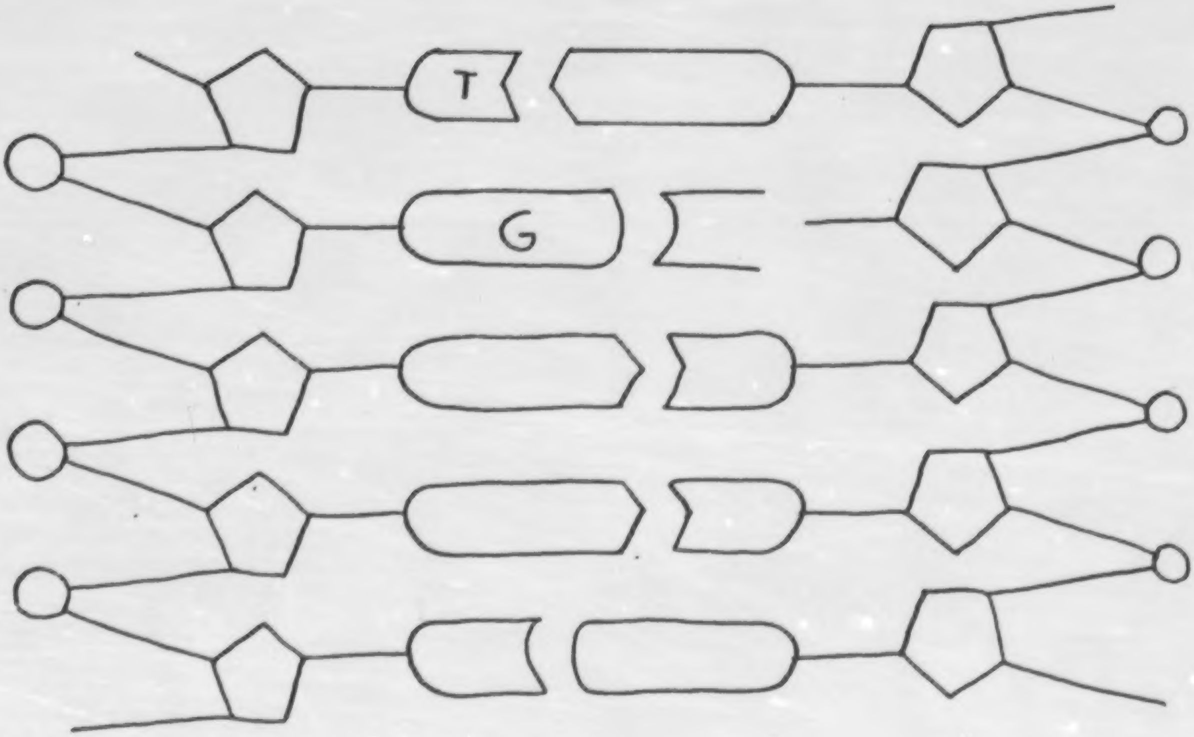
____19. The ability of hunting dogs to track is an example of a physiological adaptation.

____20. Dr. Sidney Fox devised an experiment that proved that amino acids could have been formed in the primitive environment from the four simple gases.

____21. All of the genes available to a given population make up a gene pool.

____22. One of the main differences between the plant and animal kingdoms is the fact that most organisms in the animal kingdom are heterotrophic.

STRUCTURE OF DNA



1. In red pencil, circle a single nucleotide in the diagram above.
2. Put the letter S in each symbol for a sugar group in the diagram.
3. Put the letter P in each symbol for a phosphate group in the diagram.
4. The bases in DNA are composed of carbon, hydrogen, oxygen, and _________.
5. How is the sugar unit of one nucleotide bonded to the sugar unit of another nucleotide? ____
6. What is deoxyribose? ____

7. What four bases are found in a molecule of DNA? ______________________

____

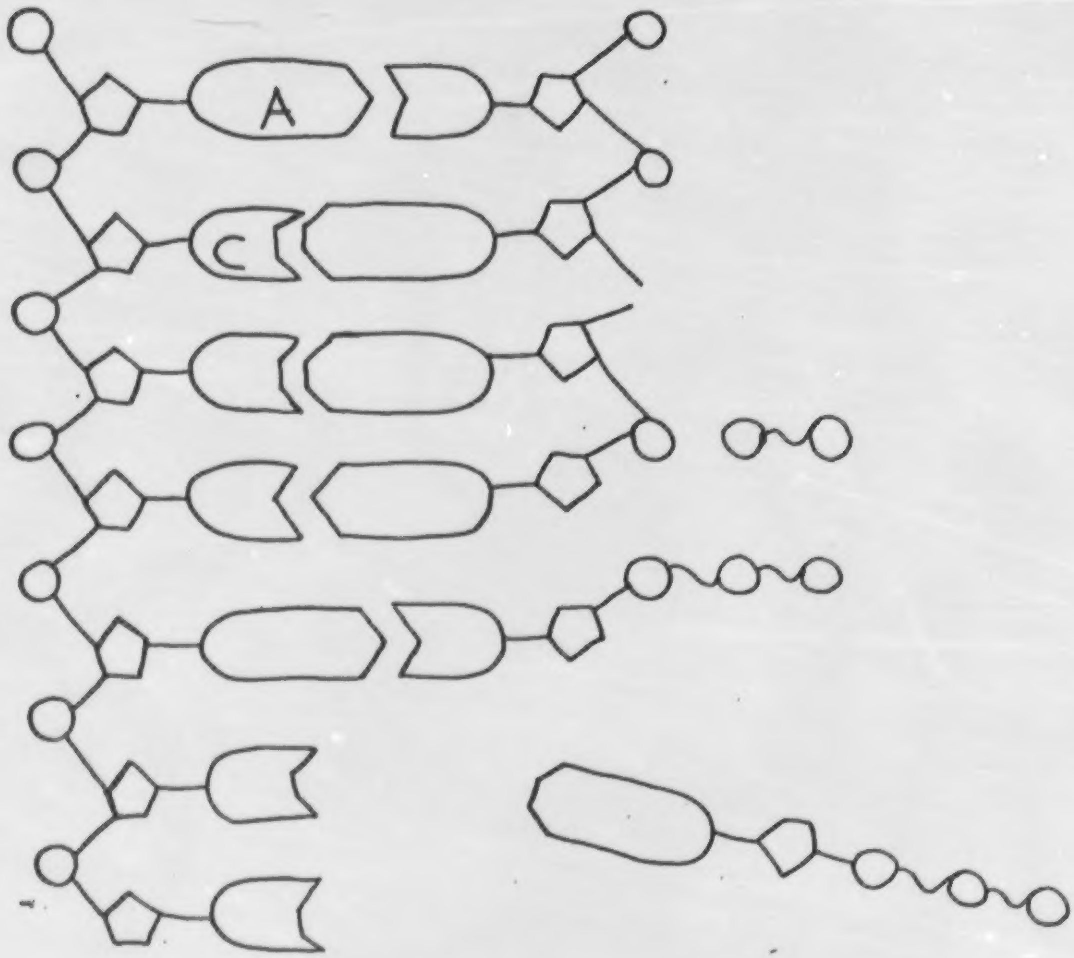
8. Two of the bases in the diagram are labeled with the first letter of their names. Label all the bases in the diagram in a similar manner.

9. Where in the cell is DNA found? ____________________________________

10. DNA controls the basic life processes in virtually every cell, and also transmits ____.

Evaluation Sample (Cont.)
Grades 10, 11, 12
Biology: Descriptive
Unit: Continuity of Life --
Reproduction, Heredity, and Evolution

REPLICATION OF DNA



1. Draw an S in the sugar units in the diagram above.
2. Draw a P in the phosphate units.
3. Label the bases in the diagram above. (Use an A for adenine, G for guanine, T for thymine, and C for cytosine.)

4. (a) To which base, or bases, can the adenine in DNA be bonded?

   ____

   (b) To which base, or bases, can the cytosine in DNA be bonded?

   ____

5. It is now fairly well-established that the ____________ of the bases in DNA controls the life activities of the cells.

6. Where do the two strands of a DNA molecule find the nucleotides they need after they separate? ______________________________

7. During the replication of DNA, what is the function of the extra phosphate groups attached to the free nucleotides? ______________________________

   ____

Evaluation Sample (Cont.)
Grades 10, 11, 12
Biology: Descriptive
Unit: Continuity of Life -- Reproduction, Heredity, and Evolution

Reference:

Testing package. Oram, Robert F. Biology: Living Systems, Chapter 7. Charles E. Merrill, 1976. Chapters 7, 8, 9, 10, 11, 12, 13, 14.

Unit Outline
Grades 10, 11, 12
Biology: Descriptive
Unit: Patterns in the Biosphere — Terrestrial and Marine, Past and Present

I. Communities

A. Interrelationships of biotic and abiotic factors
B. Aquatic versus terrestrial communities

II. Ecological Succession

A. Forest development
B. Secondary succession
C. Convergence

III. Biomes

A. Tundra and taiga
B. Temperate deciduous forest
C. Microenvironments
D. Tropical rain forest
E. Grasslands
F. Desert
G. Ocean

IV. Past Ecosystems

A. Evidence of the past
B. Origins of humans
C. Human adaptations
D. Races
E. Cultural evolution

Suggested Activities
Grades 10, 11, 12
Biology: Descriptive
Unit: Patterns in the Biosphere -- Terrestrial and Marine, Past and Present

OBJECTIVE: To sample and identify organisms in a wooded area and determine the interrelationships of these organisms in the community

TITLE: "Field Study of a Terrestrial Community"

SOURCE: Hummer, et al. *Probing Levels of Life*, Charles E. Merrill, 1976, p. 207.

OBJECTIVE: To apply a simplified version of the line transect method to determine tree dominance in a given area and infer past and future succession

TITLE: "Forest Succession Study: The Line Transect Method"

SOURCE: Unit supplied in Physical Education 694 -- Environmental Exploration, Autumn Quarter, 1979, The Ohio State University

OBJECTIVE: To observe and describe the order of succession in a microenvironment

TITLE: "Ecological Succession in a Microenvironment"

SOURCE: Hummer, et al. *Probing Levels of Life*. Charles E. Merrill, 1976, pp. 216-218.

OBJECTIVE: To examine two microcommunities and identify and compare the organisms found in each

TITLE: "Microcommunities"

SOURCE: Kaskel, et al. *Laboratory Biology: Investigating Living Systems*. Charles E. Merrill, 1976, pp. 351-356.

Text Materials

Hummer, Paul J., Jr.; Kaskel, Albert; Kennedy, James E.; and Oram, Raymond F. Probing Levels of Life. Charles E. Merrill Publishing Co., 1976.

Kaskel, Albert; Hummer, Paul J., Jr.; Kennedy, James E.; and Oram, Raymond F. Laboratory Biology: Investigating Living Systems. Charles E. Merrill Publishing Co., 1976.

Oram, Robert F. Biology: Living Systems. Charles E. Merrill Publishing Co., 1976.

Otto, James H.; Towle, Albert; and Crider, Elizabeth H. Biology Investigations. Holt, Rinehart, and Winston, Inc., 1969.

Films

The Desert Biome -- Columbus Public Library

Early Americans -- Shell Oil Company

The Grasslands -- Columbus Public Library

The High Arctic Biome -- Columbus Public Library

The Marine Biome -- Columbus Public Library

Mysteries of the Deep -- Columbus Public Library

Story in the Rocks -- Shell Oil Company

This Land -- Shell Oil Company

White Wilderness -- Columbus Public Library

Filmstrips -- High School Learning Center

Biological Communities

Sound Filmstrips -- Biology Department

Stream Life

Exemplary Activity
Grades 10, 11, 12
Biology: Descriptive
Unit: Patterns in the Biosphere -- Terrestrial and Marine, Past and Present

OBJECTIVE: To apply a simplified version of the line transect method to determine tree dominance in a given area and infer past and future succession

MATERIALS AND EQUIPMENT: See Procedure

BACKGROUND:

One of the major processes that occurs in natural systems is succession. Ecologists usually define succession as an orderly sequence of biological communities that replace one another in a given area over a period of time.

Each community in this sequence modifies the environment in such a way as to favor the plants and animals that will occupy the area next. Consider, for example, a bare rock surface. Obviously, the lack of soil (among other factors) prevents tree growth on this rock. However, lichens and mosses can get a foothold in small cracks.

Acids these plants release -- along with freezing, thawing, rain, and wind -- begin to wear away the rock and create tiny pockets of soil. Dead parts of the lichens and mosses contribute organic matter to this soil.

Eventually, enough soil accumulates to support a community of grasses, weeds, and ferns. These larger plants help create more soil. Shrubs then take over, followed by small trees and finally a mature forest.

The changes from the lichen-moss community to a fern-grass-weeds community to a shrub community to a forest community are an example of primary succession; that is, succession that begins on areas that have not previously supported life. Secondary succession, in contrast, occurs in places where the vegetation has been destroyed but where some soil remains. Fires and timber operations are two processes that bring about secondary succession.

PROCEDURE:

To study forest succession, it is necessary to determine which tree species are the most important, or dominant, in the area you are investigating.

By setting up line transects in a forest, you can describe which trees are dominant. You will also be able to infer the area's past and predict its future. We will use a simplified version of the line transect method in our study.

A. Unwind a 150-foot length of string in a straight line through the forest. This is your group's transect.

B. Any tree that hangs over your transect string will be counted in the study. For each tree:

1. Record the species.

2. Measure and record its diameter at breast height (DBH). Ignore trees under 3" in DBH.

C. Summarize your data by calculating the following information for each species.

1. Frequency; i.e., number of individuals of that species

2. Dominance; i.e., total DBH for that species

DATA ANALYSIS:

Groups will combine data and calculate the information below for each tree species.

A. Density: Average DBH for that species

B. Relative Frequency:

$$\frac{\text{Total frequency for that species}}{\text{Total frequency for all species}} \times 100$$

C. Relative Dominance:

$$\frac{\text{Total dominance for that species}}{\text{Total dominance for all species}} \times 100$$

Density is the average tree size for each species; frequency is how commonly the tree species was found; and dominance is the area taken up by each tree species. What can these three statistics tell us about the past, present, and future of our forest?

REFERENCES:

1. Andrews, William A., et al. A Guide to the Study of Terrestrial Ecology. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1974. As previously noted, this procedure has been greatly simplified from the version in Terrestrial Ecology. In addition, the terms "frequency" and "density" have been modified for this study.

2. Dasmann, Raymond F. Environmental Conservation, 4th ed. New York: John Wiley and Sons, Inc., 1976.

Evaluation Sample
Grades 10, 11, 12
Biology: Descriptive
Unit: Patterns in the Biosphere -- Terrestrial and Marine, Past and Present

Reference:

Oram, Raymond F., and Kaskel, Albert. Evaluation Program for Biology, Living Systems. Charles Merrill Publishing Co., 1976, Chapters 28, 30.

Unit Outline
Grades 10, 11, 12
Biology: Investigative
Unit: Ecology and the Biosphere

I. The Web of Life

   A. Science as a process
   B. Ecological niches
   C. The flow of energy
   D. The cycling of matter
   E. Ecological interrelationship

II. Individuals and Populations

   A. Natural population characteristics
   B. Population dynamics
      1. Density
      2. Change
      3. Determiners
      4. Growth patterns
   C. Types of populations
   D. Role of environment

III. Communities and Ecosystems

   A. Interspecific and intraspecific relationships (biotic community)
   B. Interaction of biotic and abiotic (ecosystem)
   C. Measuring biotic and abiotic factors
   D. Man's effect and role

Suggested Activities
Grades 10, 11, 12
Biology: Investigative
Unit: Ecology and the
Biosphere

OBJECTIVE: To become familiar with some common environmental problems

TITLE: "Looking at Life"

SOURCE: BSCS Green Version Text, 1978. Investigation 1.1, p. 6.

OBJECTIVE: To make observations of organisms descriptive enough to be verified by other individuals

TITLE: "Observing Living Things"

SOURCE: BSCS Green Version Text, 1978. Investigation 1.2, p. 14.

OBJECTIVE: To define one relationship between plants and animals through an analysis of the carbon cycle

TITLE: "Relationships Between a Plant and an Animal"

SOURCE: BSCS Green Version Text, 1978. Investigation 1.3, p. 27.

OBJECTIVE: To apply sampling techniques in the establishment of a population growth trend through time

TITLE: "Study of a Yeast Population"

SOURCE: BSCS Green Version Text, 1978. Investigation 2.1, p. 43.

OBJECTIVE: To apply and modify a model in the explanation of a population change

TITLE: "Population Changes: A Model"

SOURCE: BSCS Green Version Text, 1978. Investigation 2.2, p. 50.

Suggested Activities (Cont.)
Grades 10, 11, 12
Biology: Investigative
Unit: Ecology and the
Biosphere

OBJECTIVE: To compare field data on populations with predictions extrapolated from a hypothetical population and a laboratory population

TITLE: "Population Changes: Field Data"

SOURCE: BSCS Green Version Text, 1978. Investigation 2.3, p. 57.

OBJECTIVE: To enumerate some environmental conditions that affect the viability of brine shrimp eggs

TITLE: "Environment and Natality"

SOURCE: BSCS Green Version Text, 1978. Investigation 2.4, p. 67.

OBJECTIVE: To quantify two abiotic factors important to land animals

TITLE: "Abiotic Environment: A Comparative Study"

SOURCE: BSCS Green Version Text, 1978. Investigation 3.2, p. 88.

OBJECTIVE: To investigate the ecological structure and interrelationships that may exist in an urban backyard biotic community

TITLE: "Study of a Backyard Community"

SOURCE: Teacher developed

Text Materials

BSCS Green Version Text, 1978. Chapters 1, 2, 3.

Films -- Columbus Public Library

The Community

Life in the Woodlot

Population Ecology

What Is Ecology?

Sound Filmstrips -- High School Learning Center

Biological Communities

Ecology at Work: The Case of the Bighorn Sheep

Ecology: Understanding the Crises

Lab Experiments in Biology: Ecology Sampling and Field Techniques

Film Loops -- High School Learning Center

Histological Techniques: Wet Mount

Sound Slides -- High School Learning Center

Biological Catastrophies: When Nature Becomes Unbalanced

Exemplary Activity
Grades 10, 11, 12
Biology: Investigative
Unit: Ecology and the
Biosphere

OBJECTIVE: To recognize the ecological niches of community members, outline the structure and organization of the community, and describe the various relationships among community members

MATERIALS AND EQUIPMENT: See Procedure

Introduction: The study is to be done outside of class time. The study summary is to be turned in on the date designated by the instructor. Some class time will be spent on instruction in field observation techniques.

The study site may be any nearby outdoor environment capable of sustaining life. The site need not be a woods, but the more natural it is the better. The actual study area may range in size from a minimum of 100 square meters to a maximum of 5 hectares (the approximate size of the Fishinger Land Lab). The size of your study area will be influenced by what you have access to and the amount of time you can devote to the study. In general, the smaller the study area, the more detail expected; the larger the area, the more general one can be.

PROCEDURE:

The following activities constitute the study summary and are to be completed and submitted on the designated date.

ACTIVITY A: AN OUTLINE MAP

Establish the natural or artificial boundaries of your study area. Walk casually and quietly around and throughout the study area. Sketch on this page an outline map of the study area. Include pertinent landmarks that might affect the biotic community. Use appropriate symbols and a key to indicate the type and location of vegetation.

Exemplary Activity (Cont.)
Grades 10, 11, 12
Biology: Investigative
Unit: Ecology and the
Biosphere

ACTIVITY B: BIOTIC INVENTORY

As you walk slowly and quietly, observe carefully and thoughtfully the life of the area. Be sure to examine microhabitats. Complete the following lists.

Producers:

Consumers:

Decomposers:

ACTIVITY C: FOOD WEB

Using specific organisms, diagram the food web for your area. All organisms listed in the biotic inventory should be in the diagram.

ACTIVITY D: ENERGY PYRAMID

Using all the organisms listed in your inventory, diagram the energy pyramid (also called a "food pyramid" or "pyramid of numbers") that represents your community.

ACTIVITY E: RELATIONSHIPS

Using the organisms of your community, give a specific example of as many of the following ecological relationships as possible (minimum 3).

PROTECTION, HOME SITE, ETC. --

PREDATION --

COMPETITION --

MUTUALISM --

COMMENSALISM --

SUMMARY

Briefly summarize your concept of this particular biotic community based on your understanding of its:

A. STRUCTURE (what is there, relative abundance, dominant species, depth, etc.)

B. RELATIONSHIPS (ecological niches, relationship effects, etc.)

Teacher developed

Evaluation Sample
Grades 10, 11, 12
Biology: Investigative
Unit: Ecology and the
Biosphere

Investigation 2.1:

____ 1. The purpose was to study the pattern of growth of (A) a real population (B) a closed population (C) a laboratory population (D) any or all three of these.

____ 2. According to the class average data on your graph, the growth rate accelerated the most between days (A) 0 and 1 (B) 1 and 2 (C) 3 and 4 (D) 4 and 5.

____ 3. "Since a closed population has limited food and space, then a yeast population living in a sealed culture tube should increase to a point, then decrease and die off." This is (A) a general conclusion (B) a hypothesis that the data totally supports (C) a conclusion that fails to reflect correctly the data (D) a hypothesis that is partly, but not completely, supported by the data.

Investigation 2.2:

____ 4. According to the general conclusion, the pattern of growth of a model population is determined mainly by (A) the environment (B) the assumptions governing the model (C) the type of organism (D) natality and mortality.

____ 5. An advantage of semi-log graph paper is (A) it permits easier plotting of data with an extreme range (B) hypothetical populations can be plotted on it (C) it never shows negative slope (D) it is possible to put more data on it.

Investigation 2.3:

____ 6. The best statement of purpose is (A) to study the growth of mice and pheasant populations (B) to graph data that has already been collected by biologists (C) to study field data on cotton mice and pheasants (D) to study the patterns of growth of natural populations and compare them with model and closed populations.

____ 7. According to the mouse graph, the highest natality rate occurred in (A) May and June (B) June and July (C) July and August (D) September and October.

Investigation 2.4:

____ 8. Select the best general conclusion: (A) Brine shrimp hatch best in warm temperature and salt concentration of 1-4%. (B) As shown by the data, one may conclude that certain environmental factors, such as temperature and NaCl concentration, may interact to create favorable

(8) conditions for brine shrimp natality. (C) Based on this investigation, one may conclude that moderate temperature and NaCl concentrations favor brine shrimp natality. (D) From this investigation, it can be concluded that certain environmental factors influence brine shrimp natality.

____ 9. True or false: Salt water is necessary for hatching brine shrimp eggs.

____10. The measuring device on the front desk is called a (A) measuring tube (B) graduated beaker (C) milliliter tube (D) graduated cylinder.

Unit Outline
Grades 10, 11, 12
Biology: Investigative
Unit: Diversity Among
Living Things --
Classification of
Protista, Plants,
and Animals

I. Major Concepts and Ideas

- A. Animals
  1. Biological classification
  2. The meaning of "species"
  3. Complementarity of structure and function
- B. Plants
  1. Scientific names, binomial system
  2. Taxonomic keys
  3. Complementarity of structure and function
- C. Protists
  1. Kingdom protista
  2. Microbiology -- technology and techniques
  3. Distinguishing structural differences

Suggested Activities
Grades 10, 11, 12
Biology: Investigative
Unit: Diversity Among
Living Things --
Classification of
Protista, Plants,
and Animals

OBJECTIVE: To investigate the diverse structure of selected deciduous and evergreen twigs, and to identify the twigs by using taxonomic keys

TITLE: "Diversity in Plant Structure -- Winter Twigs"

SOURCE: Teacher developed using "Tree Finder" booklets

OBJECTIVE: To examine the structural characteristics that are used in animal classification

TITLE: "Levels of Classification"

SOURCE: *BSCS Green Version Text*, 1978. Investigation 4.1, p. 112.

OBJECTIVE: To apply a dichotomous key in identifying a number of organisms

TITLE: "Observing Structural Characteristics"

SOURCE: *BSCS Green Version Text*, 1978. Investigation 4.2, p. 131.

OBJECTIVE: To compare and contrast the characteristics of five organisms

TITLE: "Diversity in Animals: A Comparative Study"

SOURCE: *BSCS Green Version Text*, 1978. Investigation 4.3, p. 137.

OBJECTIVE: To identify contrasting characteristics suitable for the construction of a dichotomous key, and to recognize the diversity among leaves

TITLE: "Diversity Among Plants: Leaves"

SOURCE: *BSCS Green Version Text*, 1978. Investigation 5.1, p. 147.

OBJECTIVE: To identify plant characteristics associated with primitive and advanced classifications, and to relate this to changes in diversity through time

TITLE: "Primitive Characteristics"

SOURCE: BSCS Green Version Text, 1978. Investigation 5.2, p. 156.

OBJECTIVE: To observe the diversity of microorganisms

TITLE: "A Garden of Microorganisms"

SOURCE: BSCS Green Version Text, 1978. Investigation 6.1, p. 174.

OBJECTIVE: To replicate experiments that disproved the theory of spontaneous generation, and to apply the procedures involved in a controlled experiment

TITLE: "Spontaneous Generation"

SOURCE: BSCS Green Version Text, 1978. Investigation 6.2, p. 178.

Resources
Grades 10, 11, 12
Biology: Investigative
Unit: Diversity Among
Living Things --
Classification of
Protista, Plants,
and Animals

Text Materials

BSCS Green Version Text, 1978, Chapters 4, 5, 6.

Films

The Protist Kingdom, Columbus Library

Wee Beasties, Westerville Library

Sound Filmstrips -- High School Learning Center

The Plants

The Protists

Booklets -- Available from Metro Parks

Tree Finder

Slides -- High School Biology Department

Taxonomy: Animal, Plant, and Protist Kingdoms

Exemplary Activity
Grades 10, 11, 12
Biology: Investigative
Unit: Diversity Among
Living Things --
Classification of
Protista, Plants,
and Animals

Reference:

Investigation 6.2, "Spontaneous Generation," BSCS Green Version Text. 1978, p. 178.

Evaluation Sample
Grades 10, 11, 12
Biology: Investigative
Unit: Diversity Among
Living Things --
Classification of
Protista, Plants,
and Animals

Lab and Data Book Quiz -- Chapters 6 and 7

Evaluate the following statements of purpose (A) acceptable or (B) unacceptable.

____ 1. Inv. 6.1 To observe the diversity of microorganisms and place them in proper taxonomic groups

____ 2. Inv. 6.2 To investigate the origin of microbes by performing experiments similar to those of two early investigators, Spallanzani and Pasteur

____ 3. Inv. 7.1 To investigate the kinds, abundance, and movement of microbes in the school ecosystem

____ 4. Inv. 7.3 To investigate soil pH by testing various soil samples

____ 5. Inv. 7.4 To observe the action of microbes on the decomposition of cellulose

Evaluate the following conclusions (A) acceptable or (B) unacceptable.

Based on the results of this investigation, one may conclude that:

____ 6. Inv. 6.1 bacteria grow in the greatest variety of food sources, and molds tend to favor a more solid medium than bacteria.

____ 7. Inv. 7.1 microbes are more abundant in the busier areas of the school than in the quieter areas.

____ 8. Inv. 7.3 pH paper gives a reasonably accurate measurement of pH, and the pH of soils varies with different types of soils.

____ 9. According to your data for Inv. 7.1, microbe colonies from the busy school areas outnumbered those from the quiet areas 6 to 1. True or false?

____10. The instrument taped to the front board is correctly called (A) a sterilizing loop (B) a streaking loop (C) an innoculating loop (D) a streaking needle.

Evaluation Sample (Cont.)
Grades 10, 11, 12
Biology: Investigative
Unit: Diversity Among
Living Things --
Classification of
Protista, Plants,
and Animals

Reference:

Resource Book of Test Items: Biological Science, An Ecological Approach, BSCS. Rand McNally and Co., 1979, Chapters 4, 5, 6.

Unit Outline
Grades 10, 11, 12
Biology: Investigative
Unit: Within the Organism --
Anatomy and Physiology

I. Major Concepts and Ideas

- A. Cells
  - 1. Microscopic structure of organisms
  - 2. Principles of physical science used to explain the functions of organisms
  - 3. Cell duplication
- B. Functioning plants
  - 1. The structure of plants and their relationships to the life functions they perform
  - 2. Adaptations of land plants to the terrestrial environment
  - 3. Difference of plant growth from that of animals
- C. Functioning animals
  - 1. Obtaining energy
  - 2. Difference of the carbon-oxygen exchange system between plants and animals
  - 3. Removal of metabolic wastes
  - 4. Maintenance of an internal steady state in a constantly changing external environment
  - 5. Function of muscle and bones in human movement
- D. Behavior
  - 1. Behavior and who studies it
  - 2. Types and names of behavior in plants
  - 3. Behavior patterns in animals
  - 4. Concept of learning

Suggested Activities
Grades 10, 11, 12
Biology: Investigative
Unit: Within the Organism --
Anatomy and Physiology

OBJECTIVE: To observe the characteristics of a variety of cells

TITLE: "Observing Cells"

SOURCE: BSCS Green Version Text, 1978. Investigation 11.1, p. 360.

OBJECTIVE: To demonstrate the movement of substances through a semi-permeable membrane

TITLE: "Diffusion Through a Membrane"

SOURCE: BSCS Green Version Text, 1978. Investigation 11.2, p. 370.

OBJECTIVE: To observe cells in various stages of mitotic division

TITLE: "Mitosis and Cell Division in Plants"

SOURCE: BSCS Green Version Text, 1978. Investigation 11.3, p. 375.

OBJECTIVE: To investigate the relationship of stomate distribution, gas exchange, and photosynthetic activity

TITLE: "Gas Exchange and Photosynthesis"

SOURCE: BSCS Green Version Text, 1978. Investigation 13.1, p. 418.

OBJECTIVE: To determine the relationship between water content and rigidity of plant structures

TITLE: "Water and Turgor Pressure"

SOURCE: BSCS Green Version Text, 1978. Investigation 13.2, p. 432.

OBJECTIVE: To observe the growth patterns of corn seedlings

TITLE: "Root Growth"

SOURCE: BSCS Green Version Text, 1978. Investigation 13.3, p. 435.

OBJECTIVE: To enumerate the relationship of structure and function in the frog as a basis for comparison with other higher organisms

TITLE: "Animal Structure and Function"

SOURCE: BSCS Green Version Text, 1978. Investigation 14.1, p. 443.

OBJECTIVE: To observe the action of an enzyme under laboratory conditions

TITLE: "Action of a Digestive Enzyme"

SOURCE: BSCS Green Version Text, 1978. Investigation 14.2, p. 454.

OBJECTIVE: To measure the effect of temperature on heartbeat in Daphnia

TITLE: "A Heart at Work"

SOURCE: BSCS Green Version Text, 1978. Investigation 14.3, p. 467.

OBJECTIVE: To determine the stimuii that affect the direction of growth of roots and stems

TITLE: "Tropisms"

SOURCE: BSCS Green Version Text, 1978. Investigation 15.1, p. 499.

OBJECTIVE: To determine the stimuli that affect the movement of planaria

TITLE: "Planarian Behavior"

SOURCE: BSCS Green Version Text, 1978. Investigation 15.2, p. 509.

OBJECTIVE: To determine the behavior of saw bugs with respect to moisture and light, and to apply this information in training the saw bugs to run a maze

TITLE: "Conditioning"

SOURCE: BSCS Green Version Text, 1978. Investigation 15.3, p. 529.

Text Materials

BSCS Green Version Text, 1978. Chapters 11, 13, 14, 15.

Films -- Westerville Public Library

Man: The Incredible Machine

Miss Goodall and the Wild Chimpanzees

Monkeys, Apes, and Man

Mystery of Animal Behavior

Reptiles and Amphibians

Strange Creatures of the Night

Sound Filmstrips -- High School Learning Center

Biological Societies

Introduction to Mitosis

Introduction to the Animal Cell

Monocotyledons

Film Loops -- High School Learning Center

Cells of Onion Root Tip -- Mitotic Divisions

Cheek Epithelium Cells

Earthworm, Part 2

Earthworm, Part 3

Elodea Leaf Cells

The Frog: Anatomy of the Central Nervous System

The Frog: Circulation -- the Veins

Film Loops (Cont.)

Frog: General Dissection

The Frog, Part 3, Opening Body Cavity

The Frog, Part 4, Internal, Digestive, and Respiratory Organs

The Frog: Reproductive and Urinary Systems of the Male and Female

Osmosis: Dialysis

Phototropic Responses in Coleoptiles

Primary Growth in Trees

Smear and Squash Techniques

Transpiration: Water Loss in the Leaf

Sound Slides -- High School Learning Center

Bioclocks: Understanding the Rhythms of Life, Parts I and II

Exemplary Activity
Grades 10, 11, 12
Biology: Investigative
Unit: Within the Organism --
Anatomy and Physiology

Reference:

Investigation 14.3, "A Heart at Work," BSCS Green Version Text. 1978, pp. 467-468.

Evaluation Sample
Grades 10, 11, 12
Biology: Investigative
Unit: Within the Organism --
Anatomy and Physiology

Reference:

Resource Book of Test Items: Biological Science, An Ecological Approach, BSCS. Rand McNally and Co., 1979, Chapters 11, 13, 14, 15.

Unit Outline
Grades 10, 11, 12
Biology: Investigative
Unit: Energy and Life -- Photosynthesis and Respiration

I. Energy
    A. Source and definition
    B. Forms and transformations
    C. Roles in our lives

II. Photosynthesis
    A. Discovery
    B. Chloroplasts and chlorophyll
    C. Light and dark reactions
    D. Factors that affect rate

III. Formation of Organic Compounds
    A. Carbohydrates
    B. Fats
    C. Proteins
    D. Nucleic Acids

IV. Releasing Chemical Energy From Food
    A. Enzymes
    B. Cellular respiration -- aerobic
    C. Fermentation

Suggested Activities
Grades 10, 11, 12
Biology: Investigative
Unit: Energy and Life --
Photosynthesis and
Respiration

OBJECTIVE: To observe the effect of selected environmental factors on photosynthetic rate

TITLE: "Photosynthetic Rate"

SOURCE: BSCS Green Version Text, 1978. Investigation 12.1, p. 385.

OBJECTIVE: To apply the principle of chromatography in the separation of leaf pigments

TITLE: "Separation of Leaf Pigments"

SOURCE: BSCS Green Version Text, 1978. Investigation 12.2, p. 395.

OBJECTIVE: To use a calorimeter in an experimental determination of food energy

TITLE: "Food Energy"

SOURCE: BSCS Green Version Text, 1978. Investigation 12.3, p. 404.

OBJECTIVE: To observe factors that may affect the rate of a biochemical reaction

TITLE: "A Study of Biochemical Reactions"

SOURCE: BSCS Green Version Text, 1978. Investigation 12.4, p. 407.

Resources
Grades 10, 11, 12
Biology: Investigative
Unit: Energy and Life --
Photosynthesis and
Respiration

Text Materials

BSCS Green Version Text, 1978. Chapter 12.

Sound Filmstrips -- High School Learning Center

Amino Acid Structure and the Peptide Link

Introduction to Biological Oxidation and ATP

Introduction to Photosynthesis

Introduction to the Carbon Cycle

Photosynthesis Details I

Photosynthesis Details II

Film Loops -- High School Learning Center

Enzyme Action: Catalase

Photosynthesis: Pigments

Respiration -- Aerobic Respiration

Exemplary Activity
Grades 10, 11, 12
Biology: Investigative
Unit: Energy and Life -- Photosynthesis and Respiration

Reference:

Investigation 12.2, "Separation of Leaf Pigments," BSCS Green Version Text. 1978, p. 395.

Evaluation Sample
Grades 10, 11, 12
Biology: Investigative
Unit: Energy and Life --
Photosynthesis and
Respiration

Lab Quiz, Chapter 12

____ 1. Based on the results of Investigation 12.4, one may conclude that (A) liver contains MnO_2 (B) H_2O_2 acts as a catalyst breaking down MnO_2 (C) liver and potato break down MnO_2 (D) MnO_2 and a substance found in both potato and liver break down H_2O_2.

____ 2. Which test tube confirms the fact that there is no inorganic catalyst in the liver tissue in Investigation 12.4? (A) Tube 3 (B) Tube 4 (C) Tube 5 (D) Tube 7 (E) Tube 8

____ 3. According to the results of Investigation 12.3, the food that releases the highest amount of energy during cellular respiration is (A) sugars (B) starches (C) oils and fats (D) cannot be determined by the data.

____ 4. From the results of Investigation 12.2, one may conclude that the pigment extract from several leaves contains several pigments that can be separated by paper chromatography. This conclusion is (A) not related to the data (B) can be supported by the data (C) cannot be supported by the data (D) not necessary because the investigation has no hypothesis.

____ 5. The following is a hypothesis for Investigation 12.1. "If light intensity affects photosynthesis rate, then a green plant exposed to various light intensities should show evidence of a varying photosynthetic rate." This hypothesis is (A) acceptable, but a little general (B) acceptable and well stated (C) incorrect (D) does not relate to the purpose.

____ 6. Which of the following was a variable in Investigation 12.3? (A) The type of organic molecules burned in the calorimeter (B) Heat loss in the calorimeter (C) Energy transfer to the water (D) Weight of each food burned

____ 7. If the correct procedure was followed during Investigation 12.1, which of the following did not have an effect on the rate of photosynthesis? (A) Light intensity (B) Amount of elodea used (C) Temperature (D) Available CO_2 in the water

____ 8. The following is a conclusion from Investigation 12.1. "The above data indicates environmental factors affect the rate of photosynthesis in green plants." This conclusion is (A) good — logical and well stated (B) incorrect because it cannot be supported by the data (C) incorrect because it is too general (D) incorrect because no environmental factors were tested.

____ 9. Which of the following could not be concluded from Investigation 12.4? (A) Liver does not contain MnO_2. (B) Liver and potato both contain enzymes. (C) Sand is an inert substance. (D) Boiling does not affect the chemical activity of MnO_2.

____10. According to your chromatogram in Investigation 12.2, which of the pigments separated from the leaf extract have the least resistance and are therefore probably the smallest? (A) Carotenes (B) Xanthophylls (C) Chlorophyll a (D) Chlorophyll b

Evaluation Sample (Cont.)
Grades 10, 11, 12
Biology: Investigative
Unit: Energy and Life --
Photosynthesis and
Respiration

Reference:

Resource Book of Test Items: Biological Science, An Ecological Approach. BSCS, Rand McNally and Co., 1979, Chapter 12.

Unit Outline
Grades 10, 11, 12
Biology: Investigative
Unit: Continuity of Life -- Reproduction, Heredity, and Evolution

I. Reproduction

A. Necessity of reproduction to life
B. Relation to other biological functions
C. Organisms in which sexual and asexual reproduction occur
D. Relation of reproduction methods to the environment in which organisms live
E. Development of embryos

II. Heredity

A. Method by which characteristics are passed from one generation to another
B. Increased knowledge of heredity as an aid in understanding oneself
C. Development of new heredity characteristics
D. Application of scientific investigation to the history of the study of heredity

III. Evolution

A. Basic theories of evolution
B. Role of Charles Darwin in the advancement of science
C. Source of change in heredity characteristics
D. Formation of new species
E. Relation of organism fitness to where it lives

Suggested Activities
Grades 10, 11, 12
Biolgoy: Investigative
Unit: Continuity of Life --
Reproduction, Heredity,
and Evolution

OBJECTIVE: To identify some possible conditions in which vegetative reproduction occurs

TITLE: "Vegetative Reproduction"

SOURCE: *BSCS Green Version Text*, 1978. Investigation 16.1, p. 539.

OBJECTIVE: To duplicate the nuclear events of meiosis using pipe cleaners and beads as a model

TITLE: "A Model of Meiosis"

SOURCE: *BSCS Green Version Text*, 1978. Investigation 16.2, p. 546.

OBJECTIVE: To identify and compare the structural changes that occur in a chick embryo through the various stages of development

TITLE: "Chick Embryology"

SOURCE: *BSCS Green Version Text*, 1978. Investigation 16.3, p. 561.

OBJECTIVE: To generate and analyze probabilistic data to calculate deviation and observe the effect of sample size

TITLE: "Probability"

SOURCE: *BSCS Green Version Text*, 1978. Investigation 17.1, p. 578.

OBJECTIVE: To observe the interaction of genotype and environment in the expression of the phenotype of an organism

TITLE: "Seedling Phenotypes"

SOURCE: *BSCS Green Version Text*, 1978. Investigation 17.2, p. 588.

OBJECTIVE: To relate DNA structure to the structure of protein molecules and to identify the molecular changes associated with gene mutations

TITLE: "Gene Mutation"

SOURCE: *BSCS Green Version Text*, 1978. Investigation 17.4, p. 614.

OBJECTIVE: To investigate the gene frequencies of a population existing through time with no selective forces acting on it

TITLE: "Genetic Stability"

SOURCE: *BSCS Green Version Text*, 1978. Investigation 18.1, p. 634.

OBJECTIVE: To enumerate some factors that illustrate the interaction between the genetic makeup of an organism and its environment

TITLE: "Sickle Cells and Evolution"

SOURCE: *BSCS Green Version Text*, 1978. Investigation 18.2, p. 641.

OBJECTIVE: To analyze structural characteristics and population distribution in the formation of a concept of "species"

TITLE: "A Step in Speciation"

SOURCE: *BSCS Green Version Text*, 1978. Investigation 18.3, p. 650.

OBJECTIVE: To demonstrate the process of meiosis in the formation of gametes and to show the relationship between meiosis and heredity

TITLE: "Meiosis and Heredity"

SOURCE: Teacher developed

Text Materials

BSCS Green Version Text, 1978, Chapters 16, 17, 18.

Films -- Westerville Public Library

DNA, Molecule of Heredity

Dr. Learey and the Dawn of Man

How Life Begins

In Search of the Ancient Astronauts

Man Hunters

Sound Filmstrips -- High School Learning Center

The Emergence of Man

From Generation to Generation: Genetic Counseling

Introduction to Meiosis

Introduction to Mendelian Inheritance

Life Before Birth

Man from the Dim Past

Film Loops -- High School Learning Center

Giant Chromosomes of Drosophila

Handling Drosophila

Pollen Tube Growth

Sound Slides -- High School Learning Center

Genetic Code: DNA and RNA

Genetics and Heredity

How Life Survives: Adaptation and Evolution, Parts I and II

Exemplary Activity
Grades 10, 11, 12
Biology: Investigative
Unit: Continuity of Life --
Reproduction, Heredity,
and Evolution

OBJECTIVE: To demonstrate the process of meiosis in the formation of gametes and to show the relationship between meiosis and heredity

MATERIALS AND EQUIPMENT: 64 beads of one color; 4 beads of 2 similar colors, e.g. 2 orange (dom.) and 2 yellow (rec.); 4 beads of 2 different similar colors; 1 large sheet of paper; 1 crayon; 10 pipe cleaners

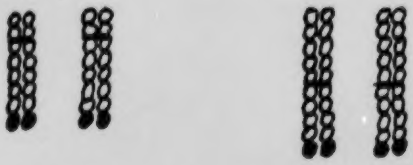
Introduction: In Investigation 16.2, BSCS Green Version Text, you demonstrated the process of meiosis in the formation of gametes. In this investigation, you will repeat that portion of the lab in order to demonstrate the relationship between meiosis and heredity.

Things to Keep in Mind:

1. Separation of homologous chromosomes is random (governed by chance).
2. Gametes combine at random.
3. In complete dominance, the dominant characteristic is expressed in the homozygous dominant (AA) and heterozygous (Aa) genotypes. The recessive characteristic is expressed in the homozygous recessive (aa) genotype.

PROCEDURE -- PART I:

1. Construct the chromosomes as you did in Investigation 16.2, BSCS Green Version Text, p. 546.



○ = backbone -- all one color

● = genes represented by similar colors representing dom. genes A and B and rec. genes a and b

2. Place paper on lab table and draw spindles.
3. Pair the two long (homologous) chromosomes and the two short ones at the equator of the spindles. There are two possibilities for aligning the chromosomes at the equator with regard to the two homologous pairs (see diagram). What are they?
4. Proceed through the steps of meiosis as in Investigation 16.2 for one of the possibilities. What is the genetic composition of the gametes produced? Use the upper case symbols A and B for the dominant traits and the lower case symbols a and b for the recessive traits.

5. Repeat step 4 for the other possibility. What is the genetic composition of the gametes produced?

6. Fill in the following chart in your data book.

genetic composition	# of gametes of that composition

What fraction of gametes has each of the possible genotypes?

PART II:

1. Construct one gamete of each of the possible genotypes and number each of the gametes (1, 2, 3, etc.).
2. Pair lab groups, designating one as male and the other as female.
3. Demonstrate fertilization of all the possible combinations by combining each male gamete with every female gamete (male 1 with female 1, then female 2, then female 3, etc.). Then fill in the following chart in your data book.

#	#	genotype	phenotype
1	1		
2	1		
3	1		
4	1		
etc.	etc.		

4. What fraction of the offspring has a particular genotype?
5. What fraction of the offspring has a particular phenotype?

Evaluation Sample
Grades 10, 11, 12
Biology: Investigative
Unit: Continuity of Life --
Reproduction, Heredity,
and Evolution

____ 1. Which is the best statement of purpose for Investigation 16.1? (A) To investigate vegetative reproduction in coleus, zabrina, geranium (B) To investigate the degree to which certain plants that do not naturally reproduce vegetatively have the ability to do so experimentally (C) To increase our understanding of vegetative reproduction (D) To learn how to propagate plants by cuttings

____ 2. Which is the most suitable general conclusion for Investigation 16.2? (A) Meiosis is the cell division process that produces gametes. (B) The processes of meiosis and mitosis differ in several ways. (C) A model may enable one to visualize better and understand the process of meiosis. (D) Crossing over can happen during meiosis.

____ 3. In Investigation 16.1, the two different structures of a flower that produce monoploid cells are (A) the pistil and stamen (B) the petal and ovary (C) the sepal and ovary (D) the stamen and anther.

____ 4. The pistil is not the site of (A) fertilization (B) egg production (C) production of pollen (D) special pollen-receiving structures.

____ 5. Which of the following are not directly involved in the process of fern reproduction? (A) sporophyte and sori (B) prothallus and gametes (C) antheridium and archegonium (D) rhizome and fronds

____ 6. Which of the following is necessary for the actual process of fertilization in both mosses and ferns? (A) water (B) wind (C) insects (D) warm temperatures

____ 7. Mature male and female moss plants are (A) diploid gametophyte plants (B) monoploid sporophyte plants (C) diploid soprophyte plants (D) monoploid gametophyte plants.

____ 8. The process resulting in the formation of the sporophyte generation in moss is known as (A) vegetative reproduction (B) fertilization (C) meiosis (D) pollination.

Indicate whether the following statements apply to (A) mitosis (B) meiosis (C) both (D) neither.

____ 9. Cell division in the anther of a flower

____10. Cell division in the reproductive structures of a moss plant resulting in a complete life cycle

Reference:

Resource Book of Test Items: Biological Science, An Ecological Approach. BSCS, Rand McNally and Co., 1979, Chapters 16, 17, 18.

Unit Outline
Grades 10, 11, 12
Biology: Investigative
Unit: Patterns in the Biosphere -- Terrestrial and Marine, Past and Present

I. Life in the Microscopic World

  A. Distribution of microorganisms
  B. Disease
    1. History
    2. Classification
    3. Environment and population interaction
  C. Soil ecosystems

II. Distribution of Organisms in the Biosphere

  A. Survival factors
  B. Distribution of life on land
  C. Climatic patterns

III. Ecological Basis of Biotic Distribution

  A. Water versus land ecosystems
  B. Major aquatic ecosystems
  C. Interrelationships between humans and aquatic ecosystems

IV. Historical and Biogeographical Bases of Biotic Distribution

  A. Evidence of the past
  B. Origin of life
  C. Past ecosystems
  D. Ecological succession

OBJECTIVE: To determine the presence of microorganisms in the immediate environment

TITLE: "Distribution of Microorganisms"

SOURCE: BSCS Green Version Text, 1978. Investigation 7.1, p. 199.

OBJECTIVE: To observe some relationships of bacteria and substances used to control them

TITLE: "Control of Bacteria"

SOURCE: BSCS Green Version Text, 1978. Investigation 7.2, p. 212.

OBJECTIVE: To determine the range of an abiotic factor that affects soil microorganisms

TITLE: "Measuring Soil pH"

SOURCE: BSCS Green Version Text, 1978. Investigation 7.3, p. 221.

OBJECTIVE: To observe one mechanism of natural recycling

TITLE: "Cellulose Decomposition"

SOURCE: BSCS Green Version Text, 1978. Investigation 7.4, p. 226.

OBJECTIVE: To examine the tolerance that some seeds have to environmental abiotic factors

TITLE: "Environmental Tolerance"

SOURCE: BSCS Green Version Text, 1978. Investigation 8.1, p. 237.

Suggested Activities (Cont.)
Grades 10, 11, 12
Biology: Investigative
Unit: Patterns in the Biosphere -- Terrestrial and Marine, Past and Present

OBJECTIVE: To visualize relationships between the abiotic and biotic features of some of the earth's major ecosystems

TITLE: "Temperature, Rainfall, and Biomes"

SOURCE: BSCS Green Version Text, 1978. Investigation 8.2, p. 264.

OBJECTIVE: To enumerate the effects of fire on selected biomes

TITLE: "Effects of Fire on Biomes"

SOURCE: BSCS Green Version Text, 1978. Investigation 8.3, p. 274.

OBJECTIVE: To become familiar with the procedure for measuring dissolved oxygen

TITLE: "Dissolved Oxygen"

SOURCE: BSCS Green Version Text, 1978. Investigation 9.1, p. 300.

OBJECTIVE: To enumerate the tolerances of some freshwater organisms to various concentrations of salt solutions

TITLE: "Effects of Salinity on Aquatic Organisms"

SOURCE: BSCS Green Version Text, 1978. Investigation 9.2, p. 313.

OBJECTIVE: To observe fossil evidence of previous life forms

TITLE: "Coal Balls"

SOURCE: BSCS Green Version Text, 1978. Investigation 10.1, p. 337.

OBJECTIVE: To study the ecology of a stream by collecting data on its chemical, physical, and biotic characteristics and analyzing how these factors interrelate.

TITLE: "Stream Study"

SOURCE: Teacher developed using following resource:
Andrews, William A., ed. Freshwater Ecology. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1972.

Text Materials

Andrews, William A., ed. Freshwater Ecology. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1972.

BSCS Green Version Text, 1978. Chapters 7, 8, 9, 10.

Films

Bacteria: Friend or Foe, Indiana University Rental

The Desert Biome, Columbus Library

How Did Life Begin?, Kent State Rental

The Grasslands, Columbus Library

The High Arctic Biome, Columbus Library

The Marine Biome, Columbus Library

Story in the Rocks, Shell Oil Company

Sound Filmstrips

Modern Biology: Environment and Survival, High School Learning Center

Stream Life, Biology Department

Film Loops -- High School Learning Center

Identification of Freshwater Organisms

Organisms Inhabiting Aquatic Vegetation

Plankton

Exemplary Activity
Grades 10, 11, 12
Biology: Investigative
Unit: Patterns in the Biosphere -- Terrestrial and Marine, Past and Present

Reference:

Investigation 8.1, "Environmental Tolerance," BSCS Green Version Text. 1978, p. 237.

Evaluation Sample
Grades 10, 11, 12
Biology: Investigative
Unit: Patterns in the Biosphere -- Terrestrial and Marine, Past and Present

Lab Quiz -- Chapter 8

____ 1. The most suitable and best expressed conclusion for Investigation 8.2 would be: (A) I conclude from this investigation that climatograms are not 100% accurate. (B) Although climatograms do not contain complete climate data, from this study one can conclude that they are reasonably accurate in associating climates with biomes. (C) We learned how to make and interpret climatograms. (D) Based on the data, I conclude that climates influence biomes and the organisms found there.

____ 2. A climatogram of Columbus, Ohio would most resemble one from (A) Laramie, Wyoming (B) Galveston, Texas (C) Pittsburgh, Pennsylvania (D) Omaha, Nebraska.

____ 3. A suitable answer for discussion question #3 in Investigation 8.2 would be: (A) Seasonal extremes are related to most trees being deciduous. (B) Hibernation (C) Birds fly south in the winter. (D) Most precipitation occurs in spring and fall.

____ 4. Fire in the ecotone Great Lakes region (Investigation 8.3) favors the growth of jack pine dominated forest because (A) fire causes the release of seeds from the pine cones (B) fire eliminates deciduous competitors (C) fire creates open areas (unshaded) that favor pine seedlings (D) all 3 of these (E) none of these.

____ 5. Based on Investigation 8.3, which of the following is not acceptable: (A) Fire may be useful in maintaining grassland. (B) Fire kills mesquite plants, but grass is not killed. (C) Ground fires have little effect on mature longleaf pines. (D) Longleaf pine seedlings are not killed by fire.

____ 6. True (A) or false (B)
According to the answer to Discussion of Data question #15 of Investigation 8.3, fire causes seeds of jack pine to be released from the cone.

____ 7. True (A) or false (B)
According to the answer to question #28 of Investigation 8.3, if you wanted bobwhite quail in your turpentine forest, you should not use fire at all.

____ 8. Desert organisms must adjust to lack of water. Dr. Krutch pointed out several of these adjustments in the film "Voice of the Desert." Which one is not one? (A) Many of the animals are nocturnal. (B) Most of the plants have spines and needles for leaves. (C) Cacti produce flowers, fruit, and seeds very slowly. (D) Desert plants are spaced naturally.

____ 9. Which of the following does not occur with changes in elevation? (A) temperature decreases (B) moisture increases (C) length of growing season decreases (D) latitude increases

____10. Which of the following is not a factor in controlling erosion in a forest situation? (A) The canopy breaks the force of rain. (B) Puddles are formed. (C) The loose soil tends to absorb large amounts of water. (D) The roots hold the forest soil in place.

Reference:

Resource Book of Test Items: Biological Science, An Ecological Approach. BSCS, Rand McNally and Co., 1979, Chapters 7, 8, 9, 10.

Unit Outline
Grades 10, 11, 12
Biology: Adjusted
Unit: Ecology and the
Biosphere

I. Population Controls

- A. Abiotic factors
  - 1. Weather variables
  - 2. Temperature
  - 3. Climate and microclimate
  - 4. Fire
  - 5. Water, carbon, oxygen, and nitrogen cycles
  - 6. Density -- independent factors
- B. Biotic factors
  - 1. Density -- dependent factors
  - 2. Habitat and niche
  - 3. Social hierarchies
  - 4. Home ranges
  - 5. Principle of competitive exclusion

II. Aerial Garbage

- A. Air pollution problems and sources
  - 1. Major air pollutants
  - 2. Local air pollution
- B. Air pollution effects
  - 1. Respiratory diseases
  - 2. Automobiles -- necessary villains?

III. Energy in the Air

- A. Noise pollution problems and sources
  - 1. Decibel scale
  - 2. Pitch and intensity
- B. Radiation problems
  - 1. Understanding radioactivity
  - 2. Nuclear power plants

IV. Aquatic Garbage

- A. Water pollution problems and sources
  - 1. BOD
  - 2. Eutrophication
  - 3. Major water pollutants
  - 4. Water treatment

V. More Water Pollution Problems

- A. Synthetic chemical pesticides
  - 1. Methods of pest control
  - 2. Biological magnification

- B. Thermal pollution
    - 1. Controlling and using heat
    - 2. Aquaculture and mariculture

VI. Land Pollution

- A. Waste -- a valuable resource
    - 1. Solid waste disposal methods
    - 2. Solving solid waste problems
- B. Land use
    - 1. Land management practices
    - 2. Urban sprawl

VII. The Human Population

- A. Population
    - 1. Pollution
    - 2. Population growth curve
    - 3. Birth and death rates
    - 4. The "green revolution"
- B. Family sizes
    - 1. Zero population growth
    - 2. Population density

OBJECTIVE: To enable students to trap and study particles that cause air pollution

TITLE: "Measuring Particulates"

SOURCE: *Biology: You and Your Environment*, John D. Cunningham.

OBJECTIVE: To determine the effect of common air pollutants on plant growth

TITLE: "Effect of Particles on Plants"

SOURCE: *Biology: You and Your Environment*, John D. Cunningham.

OBJECTIVE: To propose solutions to Utopia's environmental problems and discuss similarities and differences between the problems in your area and those in Utopia

TITLE: "Utopia"

SOURCE: *Biology: You and Your Environment*, John D. Cunningham.

OBJECTIVE: To demonstrate the effect of sewage on the amount of dissolved oxygen in water

TITLE: "Studying BOD (Biochemical Oxygen Demand)"

SOURCE: *Biology: You and Your Environment*, John D. Cunningham.

OBJECTIVE: To determine the effect detergents have on organisms, using controlled experimental methods

TITLE: "Effect of Detergents on Seeds and Young Plants"

SOURCE: *Biology: You and Your Environment*, John D. Cunningham.

OBJECTIVE: To determine the effect water temperature has on the amount of dissolved oxygen present

TITLE: "Some Biological Effects of Thermal Pollution"

SOURCE: Biology: You and Your Environment, John D. Cunningham.

Text Materials

Cunningham, John D. Biology: You and Your Environment. D.C. Heath and Company, 1976, pp. 4-113.

Teter, Harold E.; Bain, Thomas D.; and Fitzpatrick, Frederick L. Living Things. Holt, Rinehart and Winston, 1977, pp. 104-153.

Films -- Columbus Public Library

Atomic Energy -- Inside the Atom

Atomic Radiation

Challenge of the Oceans

Cosmic Rays

How to Observe

Our Friend, the Atom

Population Ecology

Water and Life

What Is Ecology?

Filmstrips -- High School Learning Center

Basic Chemistry for the Biologist

Ecology at Work: The Case of the Bighorn Sheep

Ecology: Understanding the Crisis

Slides -- High School Learning Center

Biological Catastrophies: When Nature Becomes Unbalanced, Parts I and II

Ecological Populations and Communities

Modern Biology: Environment and Survival

Problems in Ecology

Reference:

Cunningham, John D. "Studying BOD (Biochemical Oxygen Demand)," Biology: You and Your Environment. D.C. Heath and Company, 1976.

Evaluation Sample
Grades 10, 11, 12
Biology: Adjusted
Unit: Ecology and the
Biosphere

Reference:

Biology: You and Your Environment, Minicourse and Module Tests. D.C. Heath and Company, 1976, Module 1 tests.

Unit Outline
Grades 10, 11, 12
Biology: Adjusted
Unit: Diversity Among Living Things -- Classification of Protista, Plants, and Animals

I. Studying Life

- A. Characteristics of living things
    1. Classification
    2. Complementarity of structure and function
- B. Processes of biology
    1. Observation and inference
    2. Measurement
    3. Operational definitions
    4. Controlling variables

II. How Organisms Are Organized

- A. Building blocks of organisms
    1. Cell structure and function
    2. Cell organelles
    3. Variation in cells
- B. Higher levels of organization
    1. Tissues
    2. Organs
    3. Organ systems

III. Small Worlds

- A. Microorganisms
    1. Aquatic -- paramecium, euglena, ameba
    2. Multicellular forms -- rotifers, hydra, planaria
    3. Harmful and helpful forms
- B. Fungi
    1. Molds and yeasts
    2. Reproduction
    3. Preventing food spoilage

IV. Organisms and Their Environments

- A. Desert organisms
- B. Grassland organisms
- C. Forest organisms
- D. Habitat and niche
- E. Ecosystem and adaptation

Suggested Activities
Grades 10, 11, 12
Biology: Adjusted
Unit: Diversity Among Living Things -- Classification of Protista, Plants, and Animals

OBJECTIVE: To become familiar with the classification system by constructing a key

TITLE: "Keying Insects"

SOURCE: Biology: You and Your Environment, John D. Cunningham.

OBJECTIVE: To become familiar with accurate methods of investigation by designing an experiment to find out how colored light affects plant growth

TITLE: "Designing Controlled Experiments"

SOURCE: Biology: You and Your Environment, John D. Cunningham.

OBJECTIVE: To become familiar with microscope technique and observe common cells

TITLE: "Observing Common Cells"

SOURCE: Biology: You and Your Environment, John D. Cunningham.

OBJECTIVE: To observe microorganisms and learn how they respond to various stimuli

TITLE: "Observing Microorganisms"

SOURCE: Biology: You and Your Environment, John D. Cunningham.

Resources
Grades 10, 11, 12
Biology: Adjusted
Unit: Diversity Among Living Things -- Classification of Protista, Plants, and Animals

Text Materials

Cunningham, John D. Biology: You and Your Environment. D.C. Heath and Company, 1976, pp. 118-231.

Teter, Harold E.; Bain, Thomas E.; and Fitzpatrick, Frederick L. Living Things. Holt, Rinehart and Winston, 1977, pp. 104-153.

Films -- Columbus Public Library

Above the Timberline

Bacteria

The Changing Forest

The Desert

Fungi

The Grasslands

The High Arctic Biome

Life of Molds

Plankton and the Open Sea

Single Celled Animals: The Protozoa

The Temperate Deciduous Forest

The Tropical Rain Forest

The Vanishing Prairie Series

What Is Ecology?

White Wilderness Series

Filmstrips -- High School Learning Center

- Biological Communities
- Fungi and Slime Molds
- The Fungi -- Non-Green Plants
- Life in the Oceans

Film Loops -- High School Learning Center

- Cheek Epithelium Cells
- Elodea Leaf Cells
- Osmosis: Dialysis
- Transpiration: Water Loss in the Leaf

Slides -- High School Learning Center

- Ecological Succession

Transparencies -- High School Learning Center

- Biology -- The Cell
- Climatic Regions of the Earth
- Cross Section of a Leaf
- Diffusion Through a Permeable Membrane
- Diffusion Through Selectively Permeable Membrane
- Example of an Ecosystem
- The General Structure of a Leaf
- The Marine Biome

Transparencies (Cont.)

Opening and Closing of Stomata in Guard Cells

The Parts of a Cell

Principal Forest Regions of the United States

The Structure of a Bread Mold

Structure of Ameba

Structure of Euglena

Structure of Paramecium

Exemplary Activity
Grades 10, 11, 12
Biology: Adjusted
Unit: Diversity Among Living Things -- Classification of Protista, Plants, and Animals

Reference:

Cunningham, John D. "Keying Insects," Biology: You and Your Environment. D.C. Heath and Company, 1976.

Evaluation Sample
Grades 10, 11, 12
Biology: Adjusted
Unit: Diversity Among Living Things -- Classification of Protista, Plants, and Animals

Reference:

Biology: You and Your Environment, Minicourse and Module Tests. D.C. Heath and Company, 1976, Module 2 tests.

Unit Outline
Grades 10, 11, 12
Biology: Adjusted
Unit: Within the Organism --
Anatomy and Physiology

- I. Homeostasis
  - A. Biological feedback
    - 1. Corrective feedback system (negative)
    - 2. Runaway feedback system (positive)
    - 3. Receptors and effectors
  - B. Controlling body temperature
    - 1. Metabolism
    - 2. Endothermic and ectothermic
    - 3. Body size and circulation design
- II. The Breathing System
  - A. Structure of respiratory system
    - 1. Trachea, bronchi, bronchiales, alveoli
    - 2. Diaphragm, rib muscles
    - 3. Gaseous exchange
    - 4. Comparative breathing systems
  - B. Smoking versus the breathing system
    - 1. Effect on mucus-producing and ciliated cells
    - 2. Synergistic effects of air pollutants and smoking
    - 3. Relationship between smoking and cancer
- III. The Circulatory and Excretory Systems
  - A. Structure and function of circulatory system
    - 1. Anatomy of heart and vessels
    - 2. Control of heartbeat rate
    - 3. Arteries, veins, and capillaries
    - 4. Red cells, white cells, and platelets
    - 5. Immune system
    - 6. Lymphatic system
    - 7. Blood types
  - B. Structure and function of excretory system
    - 1. Anatomy of kidneys
    - 2. Anatomy of the nephron
    - 3. Ureters, bladder, urethra
    - 4. Comparative excretory and circulatory methods
- IV. Receiving Information
  - A. Structure and function of the eye
    - 1. Anatomy of the eye
    - 2. Visual defects and their correction

- B. The chemical senses
  - 1. Taste and smell receptors
  - 2. Basic tastes and odors
  - 3. Threshold stimulus
- C. Receptors in the skin
  - 1. Touch, pain, temperature, and pressure receptors
  - 2. Distribution of tactile receptors
- D. Structure and function of the ear
  - 1. Anatomy of the ear
  - 2. Semicircular canals and the sense of balance
- E. Extrasensory perception
  - 1. Telepathy
  - 2. Clairvoyance
  - 3. Precognition
  - 4. Psychokinesis

V. Coordinating Information

- A. Structure and function of the nervous system
  - 1. Basic reflexes
  - 2. Sensory and motor neurons
  - 3. Receptors and effectors
  - 4. Transmission of a nerve impulse
  - 5. All-or-none principle
  - 6. Parts of the brain
  - 7. Comparative control methods
- B. Structure and function of the endocrine system
  - 1. Hormones
  - 2. Endocrine glands
  - 3. Endocrine malfunctions and their treatment
- C. Effect of drugs on the endocrine and nervous systems
  - 1. Tolerance, dependence, and withdrawal
  - 2. Illusion, hallucinations, and delusions
  - 3. Stimulants, depressants, and hallucinogens

VI. Studying Behavior

- A. Behavior of plants
  - 1. Stimulus-response
  - 2. Positive and negative tropisms
  - 3. Kinds of tropisms
  - 4. Auxins
- B. Behavior in animals
  - 1. Taxes, reflexes, and instincts
  - 2. Phermones

OBJECTIVE: To determine the effect of temperature on the breathing rate of fish

TITLE: "Temperature and Breathing in Fish"

SOURCE: Biology: You and Your Environment, John D. Cunningham.

OBJECTIVE: To determine your lung capacity by water displacement

TITLE: "Measuring Lung Capacities"

SOURCE: Biology: You and Your Environment, John D. Cunningham.

OBJECTIVE: To observe the speed of blood cells in vessels of different sizes

TITLE: "Observing Capillaries"

SOURCE: Biology: You and Your Environment, John D. Cunningham.

OBJECTIVE: To determine your angle of vision for recognizing different colored objects in bright and dim light

TITLE: "Tunnel Vision"

SOURCE: Biology: You and Your Environment, John D. Cunningham.

OBJECTIVE: To experience sensory illusions

TITLE: "Getting Used to It"

SOURCE: Biology: You and Your Environment, John D. Cunningham.

OBJECTIVE: To observe and study changes in a plant exposed to a unilateral light source

TITLE: "Studying Tropisms"

SOURCE: Biology: You and Your Environment, John D. Cunningham.

Resources
Grades 10, 11, 12
Biology: Adjusted
Unit: Within the Organism --
Anatomy and Physiology

Text Materials

Cunningham, John D. Biology: You and Your Environment. D.C. Heath and Company, 1976, pp. 236-355.

Teter, Harold E.; Bain, Thomas E.; and Fitzpatrick, Frederick L. Living Things. Holt, Rinehart and Winston, 1977, pp. 334-432.

Films -- Columbus Public Library

Behavior in Animals

The Blood

The Eyes and Their Care

The Human Body: Circulatory System

The Nervous System

Work of the Kidneys

Filmstrips -- High School Learning Center

Aberrant Cells -- the Nature of Cancer

Film Loops -- High School Learning Center

Phototropic Responses in Coleoptiles

Respiration -- Aerobic Respiration

Transparencies -- High School Learning Center

Comparative Heart Structure of the Vertebrate Classes

Comparison of Vertebrate Brains

The Human Eye

Path of Reflex Actions

Transparencies (Cont.)

Structure of a Motor Neuron

The Structure of a Nephron

Structure of the Human Ear

Exemplary Activity
Grades 10, 11, 12
Biology: Adjusted
Unit: Within the Organism --
Anatomy and Physiology

Reference:

Cunningham, John D. "Measuring Lung Capacities," Biology: You and Your Environment. D.C. Heath and Company, 1976.

Evaluation Sample
Grades 10, 11, 12
Biology: Adjusted
Unit: Within the Organism --
Anatomy and Physiology

Reference:

Biology: You and Your Environment, Minicourse and Module Tests. D.C. Heath and Company, 1976, Module 3 tests.

Unit Outline
Grades 10, 11, 12
Biology: Adjusted
Unit: Energy and Life --
Photosynthesis and
Respiration

I. The Materials of Life

- A. Basic chemistry
    1. Organic and inorganic compounds
    2. Atomic theory
    3. Carbohydrates, fats, and proteins
- B. Membranes
    1. Diffusion and osmosis
    2. Surface area and volume relationships
    3. Metabolism

II. Producers

- A. Plant nutrition
    1. Van Helmont's and Priestley's experiments
    2. Photosynthesis and respiration compared
    3. Chromatography
- B. Transport of materials in plants
    1. Translocation
    2. Transpiration
    3. Root and stem structure

III. Consumers

- A. Food chains and webs
    1. Producers, consumers, and decomposers
    2. Herbivores, carnivores, and omnivores
    3. Biomass
- B. Metabolism
    1. Calorie and kilocalorie
    2. Enzymes
    3. Basal metabolic rate
    4. Carbohydrates, fats, and proteins
    5. Vitamins and minerals

IV. Consumer Nutrition

- A. Structure and function of the digestive system
    1. Ingestion, digestion, and egestion
    2. Absorption, circulation, and utilization
    3. Digestive enzyme action
    4. Tooth structure and dental hygiene
- B. Energy and materials
    1. Energy transformation
    2. Ten percent rule
    3. Recycycling of materials

C. Food differences and problems
  1. World hunger and its solution
  2. Problems of underweight and overweight

Suggested Activities
Grades 10, 11, 12
Biology: Adjusted
Unit: Energy and Life --
Photosynthesis and
Respiration

OBJECTIVE: To observe plant pigments by separating them with paper chromatography

TITLE: "Studying Plant Pigments"

SOURCE: _Biology: You and Your Environment_, John D. Cunningham.

OBJECTIVE: To measure the heat energy in food by making and using your own calorimeter

TITLE: "Making a Calorimeter"

SOURCE: _Biology: You and Your Environment_, John D. Cunningham.

OBJECTIVE: To study and observe the digestive action of salivary amylase

TITLE: "Chemical Digestion in the Mouth"

SOURCE: _Biology: You and Your Environment_, John D. Cunningham.

OBJECTIVE: To observe starch production in plants

TITLE: "Foodmaking by Plants"

SOURCE: _Biology: You and Your Environment_, John D. Cunningham.

OBJECTIVE: To visualize the effect of osmosis on plant cells

TITLE: "Studying Osmosis"

SOURCE: _Biology: You and Your Environment_, John D. Cunningham.

OBJECTIVE: To determine the effect of common chemicals on the growth of molds, using controls for comparisons

TITLE: "Effects of Chemicals on Mold Growth"

SOURCE: Biology: You and Your Environment, John D. Cunningham.

OBJECTIVE: To determine the organic content of different soils

TITLE: "Measuring the Organic Content of Soil"

SOURCE: Biology: You and Your Environment, John D. Cunningham.

Resources
Grades 10, 11, 12
Biology: Adjusted
Unit: Energy and Life --
Photosynthesis and
Respiration

Text Materials

Cunningham, John D. *Biology: You and Your Environment*. D.C. Heath and Company, 1976, pp. 360-473.

Oram, Raymond F. *Biology: Living Systems*. Charles E. Merrill Publishing Company, 1976, pp. 518-585.

Films -- Columbus Public Library

How the Body Uses Energy

The Physical Environment

Plant Motions -- Roots, Stems, Leaves

The Role of the Green Plant

Roots of Plants

Filmstrips -- High School Learning Center

Foodwebs and Pyramids

Introduction to Photosynthesis

Material Cycles in Nature

Nutritional Relations in Nature

Film Loops -- High School Learning Center

Elodea Leaf Cells

Photosynthesis: Pigments

Transpiration: Water Loss in the Leaf

Exemplary Activity
Grades 10, 11, 12
Biology: Adjusted
Unit: Energy and Life --
Photosynthesis and
Respiration

Reference:

Cunningham, John D. "Effects of Chemicals on Mold Growth," Biology: You and Your Environment. D.C. Heath and Company, 1976.

Evaluation Sample
Grades 10, 11, 12
Biology: Adjusted
Unit: Energy and Life --
Photosynthesis and
Respiration

Reference:

Biology: You and Your Environment, Minicourse and Module Tests. D.C. Heath and Company, 1976, Minicourse tests 4-1, 4-2, 4-3.

Unit Outline
Grades 10, 11, 12
Biology: Adjusted
Unit: Continuity of Life --
Reproduction, Heredity,
and Evolution

I. Reproduction, Growth, and Development I

- A. Sexual reproduction in plants
  1. Meiosis
  2. Anatomy of the flower
  3. Pollination and fertilization
  4. Development of seed and fruit
- B. Asexual reproduction in plants
  1. Tubers, bulbs, corms, rhizomes
  2. Cuttings, budding, grafting
  3. Spores

II. Reproduction, Growth, and Development II

- A. Animal reproduction -- an overview
  1. Regeneration
  2. External and internal fertilization
- B. Human reproduction
  1. Structure and function of male and female sex organs
  2. Menstrual cycle
  3. Fetal development and childbirth
  4. Venereal diseases
- C. Life cycle of animals
  1. Metamorphosis -- complete and incomplete
  2. Direct development

III. Patterns of Inheritance

- A. Mendel's Theory
  1. Pure breeding versus hybrids
  2. Dominant and recessive traits
  3. Phenotype and genotype
  4. Calculating ratios
  5. Incomplete dominance
  6. Heredity and environment
- B. What and where are genetic messages?
  1. Structure and function of DNA
  2. Genes and chromosomes
  3. RNA -- DNA's helper

IV. Human Genetics

- A. Human traits
  1. Dominant and recessive traits
  2. Pedigrees
  3. Polygenes

    4. Twin studies
    5. Sex determination
    6. Turner's and Klinefelter's syndromes
    7. Sex-influenced messages
    8. Sex-linked traits

V. Changing Organisms

  A. Evolution
    1. Spontaneous generation
    2. Biogenesis
    3. Lamarck's and Darwin's theories
    4. Pasteur's experiment
  B. Mechanisms of evolution
    1. Natural and artificial selection compared
    2. Adaptation
    3. Mutation
    4. Barriers, isolation, and speciation

Suggested Activities
Grades 10, 11, 12
Biology: Adjusted
Unit: Continuity of Life --
Reproduction, Heredity,
and Evolution

OBJECTIVE: To study and observe the parts of a flower as they relate to a plant's reproduction

TITLE: "Studying Flower Parts"

SOURCE: Biology: You and Your Environment, John D. Cunningham.

OBJECTIVE: To observe regeneration in the planarian

TITLE: "Asexual Reproduction in Planarians"

SOURCE: Biology: You and Your Environment, John D. Cunningham.

OBJECTIVE: To become familiar with the laws of probability by flipping two coins for sixty trials

TITLE: "Flipping Coins"

SOURCE: Biology: You and Your Environment, John D. Cunningham.

OBJECTIVE: To provide an opportunity to observe that the number of different genes does change in time

TITLE: "Changing Gene Numbers"

SOURCE: Biology: You and Your Environment, John D. Cunningham.

OBJECTIVE: To acquaint the students with the structure of DNA

TITLE: "DNA"

SOURCE: Biology: You and Your Environment, John D. Cunningham.

Resources
Grades 10, 11, 12
Biology: Adjusted
Unit: Continuity of Life --
Reproduction, Heredity,
and Evolution

Text Materials

Cunningham, John D. Biology: You and Your Environment. D.C. Heath and Company, 1976, pp. 478-589.

Teter, Harold E.; Bain, Thomas E.; and Fitzpatrick, Frederick L. Living Things. Holt, Rinehart and Winston, 1977, pp. 50-92.

Films -- Columbus Public Library

Biography of the Unborn

Cell Reproduction

DNA -- Molecule of Heredity

Gene Action

Laws of Heredity

Meiosis

Origin of Life

Seed Germination

Sex Cells

Filmstrips -- High School Learning Center

DNA -- A Key to All Life

DNA and Protein Synthesis

DNA and RNA: Deciphering the Code of Life

DNA -- Structure and Replication

Dominance

From Generation to Generation, Genetic Counseling

Genetics and the Cell

How Cells Divide

Incomplete Dominance, Segregation, Punnett Square

Independent Assortment

Introduction to Meiosis

Introduction to Mendelian Inheritance

Maturation of Gametes

New Trait Combinations and Mutations

Population Genetics

Redesigning Man: Science and Human Values

Transparencies -- High School Learning Center

Contrasting Traits -- Garden Pea

Dihybrid Cross

DNA Molecule

Hybrid Cross -- Guinea Pigs

Incomplete Dominance -- Four O'Clocks

Incomplete Dominance -- Shorthorn Cattle

Inheritance of Sex -- Drosophilia

Mendel's Law of Segregation

Mitosis -- Animal Cell

Mutations in Reproductive Cells of Drosophilia

Spermatogenesis, Oogenesis, Fertilization

Exemplary Activity
Grades 10, 11, 12
Biology: Adjusted
Unit: Continuity of Life --
Reproduction, Heredity,
and Evolution

Reference:

Cunningham, John D. "Asexual Reproduction in Planarians," Biology: You and Your Environment. D.C. Heath and Company, 1976.

Evaluation Sample
Grades 10, 11, 12
Biology: Adjusted
Unit: Continuity of Life --
Reproduction, Heredity,
and Evolution

Reference:

Biology: You and Your Environment, Minicourse and Module Tests. D.C. Heath and Company, 1976, Module 5 tests.

Unit Outline
Grades 10, 11, 12
Biology: Adjusted
Unit: Patterns in the Biosphere -- Terrestrial and Marine, Past and Present

I. Populations

   A. Population size and spacing
      1. Uniform and clumped spacing
      2. Typical growth curve
      3. Population density formula
      4. Sampling methods
   B. Population changes
      1. Biotic potential
      2. Carrying capacity
      3. Environmental resistance

II. Communities

   A. Predator-prey interactions
      1. Interspecific competition
      2. Intraspecific competition
   B. Other community interactions
      1. Human effects on communities
      2. Parasite-host interactions
      3. Pathogen-host interactions
      4. Commensalism and mutualism

III. Environments of Organisms

   A. Major biomes
      1. Tundra and polar ecosystems
      2. Shore and ocean ecosystems
      3. The soil ecosystem
   B. Explaining ecosystems
      1. Life zones
      2. Basic meteorology and climatology

IV. The History of Life

   A. Measuring time
      1. Geologists and archaeologists
      2. Dendrochronology
      3. Palynology
      4. Atomic clocks
      5. The fossil record
   B. Changing environment
      1. Continental drift
      2. Succession

Suggested Activities
Grades 10, 11, 12
Biology: Adjusted
Unit: Patterns in the Biosphere -- Terrestrial and Marine, Past and Present

OBJECTIVE: To identify abiotic factors that change the size of populations

TITLE: "Environmental Resistance and Microorganisms"

SOURCE: Biology: You and Your Environment, John D. Cunningham.

OBJECTIVE: To separate the alga and fungus to determine if they can live by themselves

TITLE: "Observing Lichens"

SOURCE: Biology: You and Your Environment, John D. Cunningham.

Resources
Grades 10, 11, 12
Biology: Adjusted
Unit: Patterns in the Biosphere -- Terrestrial and Marine, Past and Present

Text Materials

Cunningham, John D. *Biology: You and Your Environment*. D.C. Heath and Company, 1976.

Oram, Raymond F. *Biology: Living Systems*. Charles Merrill Publishing Company, 1976.

Films -- Columbus Public Library

Amphibian Embryo

Interrelationships for Survival

Miss Goodall and the Wild Chimpanzee

The Mystery of Life

Origin of Life

Population Ecology

Social Insects: The Honey Bee

Filmstrips -- High School Learning Center

Biological Societies

Ecology at Work: The Case of the Bighorn Sheep

Ecological Populations and Communities

Exemplary Activity
Grades 10, 11, 12
Biology: Adjusted
Unit: Patterns in the Biosphere -- Terrestrial and Marine, Past and Present

Reference:

Cunningham, John D. "Environmental Resistance and Microorganisms," Biology: You and Your Environment. D.C. Heath and Company, 1976.

Evaluation Sample
Grades 10, 11, 12
Biology: Adjusted
Unit: Patterns in the Biosphere -- Terrestrial and Marine, Past and Present

Reference:

Biology: You and Your Environment, Minicourse and Module Tests. D.C. Heath and Company, 1976, Minicourse tests 4-4, 4-5, 4-6, 5-6.

Unit Outline
Grades 10, 11, 12
Chemistry R
Unit: Fundamental Concepts

I. The Science of Chemistry

A. Introduction
   1. Chemistry: a physical science
   2. Keystones of modern chemistry
   3. Methods of science
B. Matter and energy
   1. Concept of matter
   2. Mass and weight
   3. Density of matter varies
   4. Three phases of matter
   5. Properties of matter
   6. Concept of energy
   7. Forms of energy
   8. Conservation of matter and energy
C. Measurements in chemistry
   1. Metric system
   2. Units of the metric system
   3. Temperature and heat
   4. Measuring temperature
   5. Uncertainty in measurements
   6. Significant figures
   7. Exponential notation
   8. Operations with significant figures
   9. Operations with units

II. Matter and Its Changes

A. Composition of matter
   1. Three general classes of matter
   2. Mixtures
   3. Substances include compounds and elements
   4. The known elements
   5. The earth's elemental composition
   6. Two general classes of elements
   7. Chemical symbols
   8. Significance of a symbol
   9. Compounds differ from mixtures
   10. Law of definite composition
   11. Common examples of mixtures and compounds
B. Changes in matter
   1. Physical changes
   2. Chemical changes
   3. Chemical reactions involve energy
   4. Reaction tendencies
   5. Nuclear changes

Suggested Activities
Grades 10, 11, 12
Chemistry R
Unit: Fundamental Concepts

OBJECTIVE: To acquaint students with laboratory equipment and skills to be used during the school year, specifically the Bunsen burner, the gas generator, glass manipulation, filtration, and evaporation

TITLE: "Basic Skills"

SOURCE: Teacher developed from the Upper Arlington chemistry files

OBJECTIVE: To measure various physical properties of matter and to determine the accuracy of such measurements

TITLE: "Measurements and Accuracy"

SOURCE: Experiment #2, Exercises and Experiments in Chemistry, pp. 105-106

OBJECTIVE: To recognize some differences in properties of two elements; to recognize differences between mixtures and compounds

TITLE: "General Classes of Matter"

SOURCE: Experiment #3, Exercises and Experiments in Chemistry, pp. 107-108

OBJECTIVE: To study the differences between physical and chemical changes in matter

TITLE: "Physical and Chemical Changes"

SOURCE: Experiment #4, Exercises and Experiments in Chemistry, pp. 109-110

OBJECTIVE: To determine the melting point of paradichlorobenzene; to plot a time-temperature graph of experimental facts and interpret them in terms of energy and entropy changes involved in phase change

TITLE: "Energy and Entropy"

SOURCE: Experiment #6, Exercises and Experiments in Chemistry, pp. 113-114

Text Materials

Metcalfe, H. Clark; Williams, John E.; and Castka, Joseph F. *Modern Chemistry*. Holt, Rinehart and Winston, Inc., 1974, pp. 1-46.

Metcalfe, H. Clark; Williams, John E.; and Castka, Joseph F. *Exercises and Experiments in Chemistry*. Holt, Rinehart and Winston, Inc., 1974.

Exemplary Activity
Grades 10, 11, 12
Chemistry R
Unit: Fundamental Concepts

Reference:

Metcalfe, H. Clark; Williams, John E.; and Castka, Joseph F. "Energy and Entropy," Experiment #6, Exercises and Experiments in Chemistry. Holt, Rinehart and Winston, Inc., 1974.

Evaluation Sample
Grades 10, 11, 12
Chemistry R
Unit: Fundamental Concepts

Reference:

Metcalfe, H. Clark; Williams, John E.; and Castka, Joseph F. Test #1, Tests in Chemistry. Holt, Rinehart, and Winston, Inc., 1974.

Unit Outline
Grades 10, 11, 12
Chemistry R
Unit: Classification of Elements

I. Chemical Change
(See Fundamental Concepts Unit)

II. Structure

- A. Atomic structure
  1. Particles of matter
  2. The atomic theory
  3. The structure of the atom
  4. The characteristics of electrons
  5. The nucleus of the atom
  6. Hydrogen atoms
  7. Helium atoms
  8. Lithium atoms
  9. Other atoms of the second series
  10. The atoms of the third series
  11. Atomic mass
  12. The Avagadro number and the mole
  13. Atomic weight
- B. Arrangement of electrons in atoms
  1. The nucleus and moving electrons
  2. Electromagnetic radiation
  3. Spectra of atoms
  4. Wave-mechanics concept of an atom
  5. Quantum numbers
  6. Electron configuration of atoms of first three series
  7. Atoms of the fourth series
  8. Atoms of the fifth series
  9. Atoms of the sixth series
  10. Atoms of the seventh series

III. The Periodic Table

- A. The periodic law
  1. Mendeleev's periodic table
  2. Mosley determines atomic numbers
  3. The periodic law
  4. Arrangement of modern periodic table
  5. Size of atoms: a periodic property
  6. Ionization energy
  7. Ionization energy to remove successive electrons
  8. Electron affinity
  9. Value of the periodic table

IV. Bonding

A. Chemical bonds
   1. Elements form compounds
   2. Valence electrons and chemical bonds
   3. Ionic bonding (electrovalence)
   4. Energy change in ionic bonding
   5. Oxidation and reduction
   6. Formation of magnesium bromide from its elements
   7. Elements with several oxidation numbers
   8. Relative sizes of atoms and ions
   9. Covalent bonding (covalence)
   10. Covalent bonding of unlike atoms
   11. Resonance
   12. Hybridization
   13. More about particles of matter
   14. Size of molecules
   15. Electronegativity
   16. Electronegativity difference and chemical bonding
   17. Molecular polarity
   18. Polyatomic ions
   19. Summary of oxidation-number rules

Suggested Activities
Grades 10, 11, 12
Chemistry R
Unit: Classification of
Elements

OBJECTIVE: To measure the wavelength of the bright-line spectrum of hydrogen (red line) and of mercury (purple line)

TITLE: "Bright Line Spectrum of Hydrogen (Red) and Mercury (Purple)"

SOURCE: Modified exercise from Exercises and Experiments in Chemistry

Instrument skills gained — use of spectroscope, diffraction gratings, and gas discharge tubes

OBJECTIVE: To become acquainted with the general organization and usefulness of the periodic table; to learn some of the specific characteristics of hydrogen and the elements in Groups IA, IIA, VIIA; to become familiar with different types of reactions

TITLE: "Periodicity in the Properties of Some Representative Elements"

SOURCE: Modified exercise from Laboratory Experiments for Foundations of Chemistry

OBJECTIVE: To construct models of molecules of covalent substances in order to show how their shapes and structure are related to their polarity

TITLE: "Covalent Molecules"

SOURCE: Exercises and Experiments in Chemistry

Resources
Grades 10, 11, 12
Chemistry R
Unit: Classification of
Elements

Text Materials

Metcalfe, H. Clark; Williams, John E.; and Castka, Joseph F. Modern Chemistry. Holt, Rinehart and Winston, Inc., 1974, pp. 30-120.

Lab Materials

Metcalfe, H. Clark; Williams, John E.; and Castka, Joseph F. Exercises and Experiments in Chemistry. Holt, Rinehart and Winston, Inc., 1974, pp. 115-116, 117-118.

Toon, Ernest R., and Ellis, George L. Laboratory Experiments for Foundations of Chemistry. Holt, Rinehart and Winston, Inc., 1968, pp. 38-42.

Films

Chemical Bonding, Mod (Modern Film Rentals) 4157

Chemical Families, Mod 4112

Equilibrium, Mod 4124

Hydrogen Atom as Viewed by Quantum Mechanics, Mod 4149

Ionization Energy, Mod 4151

Molecular Motions, Mod 4115

Molecular Spectroscopy, Mod 4142

Shapes and Polarities of Molecules, Mod 4154

Evaluation Materials

Metcalfe, H. Clark; Williams, John E.; and Castka, Joseph F. Tests in Chemistry. Holt, Rinehart and Winston, Inc., 1974, tests number 2, 3, 4, and 5.

Exemplary Activity
Grades 10, 11, 12
Chemistry R
Unit: Classification of
Elements

OBJECTIVE: By observing the properties of one or two elements in a given group of the periodic table, to predict some of the properties of the other members of the group

MATERIALS AND EQUIPMENT: See Procedure

PROCEDURE:

In this exercise you will investigate the properties and behavior of some of the elements in several of the vertical groups of the periodic table. You will first classify the elements you studied as either metallic or nonmetallic. You will then use the rather limited evidence to determine general trends that occur in metallic and nonmetallic characteristics as you go down a group or across a period of the periodic table. In addition, you will try to predict the behavior of other elements in the table.

1. Carefully examine samples of the elements that have been provided. For each, note 1) the physical state at room temperature, 2) the color, 3) the luster, and 4) the general appearance (metallic, powdery, waxy). You might want to use a table. Classify each element as a metal or a nonmetal on the basis of these physical characteristics (properties).

2. Put about 5 ml of dilute hydrochloric acid (HCl) in a clean test tube. Cut a piece of magnesium ribbon about 5 cm long.

3. Drop the magnesium ribbon into the acid and have your partner immediately hold a lighted splint at the mouth of the test tube. Repeat the procedure, this time thrusting a glowing splint into the test tube. The gas produced is hydrogen. Record the properties of the product and note any energy changes.

4. Repeat the procedure in step 3, using a small piece of calcium.

5. Dissolve a small quantity of magnesium oxide in water. Test the solution with litmus paper, which turns red in acidic solution and blue in basic solution.

6. Repeat the procedure in step 5, using a small quantity of calcium oxide instead of magnesium oxide.

7. In three separate test tubes place respectively 2 ml of sodium chloride ($NaCl$), sodium bromide ($NaBr$), and sodium iodide (NaI) solutions. To each test tube add a drop of a silver nitrate solution. Record your observations. The metallic binary compounds of the halogens are called halogenides.

8. Cut a piece of sodium the size of a grain of rice and examine the freshly cut surfaces. Record your observations. Drop the small piece into a 250 ml beaker that is half-filled with water containing several drops of phenolphthalein. Quickly cover the beaker with your wire gauze.

9. Repeat the procedure in step 8, using a small piece of potassium. Note the relative reactivities of sodium and potassium. The gas evolved in both reactions is hydrogen.

10. Place a small amount of red phosphorus (size of a rice grain) in a clean combustion spoon and ignite in a Bunsen flame. Lower the spoon into a wide-mouth bottle containing 5-10 ml of water (distilled variety). Cover as completely as possible with a glass plate. After burning has ceased, remove the spoon and vigorously shake the contents of the bottle. The white smoke is an oxide of phosphorus. Test the solution with litmus.

11. Repeat the procedure in step 10, using sulfur instead of red phosphorus.

Suggested Discussion Topics

1. Draw an abbreviated periodic table showing the elements that you have studied in this lab. Draw two arrows, one below and one to the left of the table, and label the arrows to show increase in metallic properties.

2. Draw another arrow below the table and label it to show increase in acidic nature of oxides. Explain the relationship between type of element and nature (acidic or basic) of oxide formed.

3. In general, explain where the nonmetallic elements are located in the periodic table.

4. Explain, from the evidence collected in this exercise, whether metallic elements form basic or acidic oxides.

5. Write a balanced chemical equation for the reaction of calcium with hydrochloric acid.

6. Make the following predictions:

   a. Whether or not barium, element number 56, would react with hydrochloric acid. If so, write the balanced chemical equation.

   b. Whether cesium, element number 55, would be more or less reactive than potassium.

6. (Cont.)

   c. Write the chemical equation for the reaction between calcium oxide and water.

   d. Whether the reaction between the oxide of strontium, element number 38, and water would be acidic or basic.

   e. What would the color and solubility of silver astatide be?

   f. Write the formulas for hydrobromic acid and gallium oxide. Gallium is element number 31.

   g. Sulfur forms the following compounds: sulfur dioxide, SO_2; hydrogen sulfide, H_2S; and sulfuric acid, H_2SO_4. Write the names and formulas for analogous compounds that might be formed by tellurium, element number 52.

Evaluation Sample
Grades 10, 11, 12
Chemistry R
Unit: Classification of
Elements

Reference:

Metcalfe, H. Clark; Williams, John E.; and Castka, Joseph F. Tests #2, 3, 4, 5, Tests in Chemistry. Holt, Rinehart, and Winston, Inc., 1974.

Unit Outline
Grades 10, 11, 12
Chemistry R
Unit: Chemical Formulas
and Equations

I. Chemical Composition

- A. Table of ions and their charges
- B. Writing chemical formulas
- C. Writing the formulas for other compounds
- D. Naming compounds from their formulas
- E. Significance of chemical formulas
- F. Molecular weight
- G. Formula weight of a compound
- H. Percentage composition of a compound
- I. Law of definite composition and atomic theory
- J. Law of multiple proportions
- K. Mole concept
- L. Determining the empirical formula of a compound

II. Chemical Equations

- A. Formula equations
- B. Factors in equation writing
- C. Procedure in writing equations
- D. General types of chemical reactions
- E. Six kinds of decomposition reactions
- F. Four kinds of replacement reactions
- G. Many reactions are reversible
- H. The activity series of the elements
- I. Stoichiometric relations
- J. Mole relations of reactants and products
- K. Mole method of solving mass-mass problems

Suggested Activities
Grades 10, 11, 12
Chemistry R
Unit: Chemical Formulas
and Equations

OBJECTIVE: To determine the mass of oxygen in a sample of potassium chlorate; to gain practice in precision work in the laboratory

TITLE: "Determination of Oxygen in Potassium Chlorate"

SOURCE: Experiment #9, Exercises and Experiments in Chemistry, pp. 119-120

OBJECTIVE: To show the Law of Conservation of Atoms in chemical reactions; to relate chemical reactions to chemical equations

TITLE: "Balancing Chemical Equations"

SOURCE: Experiment #10, Exercises and Experiments in Chemistry, pp. 121-122

OBJECTIVE: To show that chemical reactions fall into a rather limited variety of types or categories, as preparation for developing skill in equation writing

TITLE: "Types of Chemical Reactions"

SOURCE: Experiment #12, Exercises and Experiments in Chemistry, pp. 125-128

Resources
Grades 10, 11, 12
Chemistry R
Unit: Chemical Formulas
and Equations

Text Materials

Metcalfe, H. Clark; Williams, John E.; and Castka, Joseph F. Modern Chemistry. Holt, Rinehart, Winston, 1974, pp. 121-162.

Metcalfe, H. Clark; Williams, John E.; and Castka, Joseph F. Exercises and Experiments in Chemistry. Holt, Rinehart, Winston, 1974, pp. 17-24.

Exemplary Activity
Grades 10, 11, 12
Chemistry R
Unit: Chemical Formulas
and Equations

Reference:

Metcalfe, H. Clark; Williams, John E.; and Castka, Joseph F. Exercises and Experiments in Chemistry, Experiment #12. Holt, Rinehart, and Winston, 1974, pp. 125-128.

Evaluation Sample
Grades 10, 11, 12
Chemistry R
Unit: Chemical Formulas
and Equations

Reference:

Metcalfe, H. Clark; Williams, John E.; and Castka, Joseph F. Tests #6 and 7, Tests in Chemistry. Holt, Rinehart, and Winston, Inc., 1974.

Unit Outline
Grades 10, 11, 12
Chemistry R
Unit: Measurement

I. Metric System

   A. Three fundamental quantities measured
      1. Length
      2. Volume (capacity)
      3. Mass
   B. Corresponding units for measurement
      1. Meter
      2. Liter
      3. Gram
   C. Conversion of units (metric versus English)

II. Temperature and Heat

   A. Measuring temperature
      1. Units of temperature
      2. Temperature scales
   B. Measuring heat
      1. Units of heat
      2. Concept of specific heat; the heat equation

III. Uncertainty in Measurements

   A. Significant figures
   B. Exponential notation
   C. Operations with significant figures

IV. Operation with Units

   A. Factor-label system, dimensional analysis
      1. Metric conversions by factor label
      2. Density problems
      3. Mole problems

Suggested Activities
Grades 10, 11, 12
Chemistry R
Unit: Measurement

(See Fundamental Concepts Unit)

Resources
Grades 10, 11, 12
Chemistry R
Unit: Measurement

Text Materials

Metcalfe, H. Clark; Williams, John E.; and Castka, Joseph F. Modern Chemistry. Holt, Rinehart and Winston, Inc., 1974, pp. 12-29. (Note: Basic measurement concepts are involved in the above section of the text. Naturally, the measurement theme recurs throughout the course.)

Films -- High School Learning Center

Powers of Ten

Resource Books on Closed Reserve (Learning Center)

Tilbury, Glen. Problem Solving in Chemistry. Rand McNally and Co., 1976.

Tapes

Cathers, Robert E. and Zandler, Melvin E. Auto-Tutorial Problem Solving Modules for General Chemistry. 36 cassette tapes, tape player, booklet showing all problems solved.

Teacher Developed Departmental Information Sheets

Significant Figures
Exponential Numbers
Use of Centigram Balance (with diagram)
The Metric System
Density
Others

Teacher Developed Departmental Drills and Worksheets

Significant Figure Drill Exercises
Exponential Number Drill Exercises
Metric Drill Sheets
Density Worksheets
Mole Worksheets and Study Guide
Stoichiometry Worksheets
Others

Pretest

Scott, Peter C. Hein's Foundations of Chemistry (Study Guide), "Chemistry Math Evaluation Pretest for Students." Dickenson Publishing Co., 1976.

Evaluation Materials

Teacher developed

Exemplary Activity
Grades 10, 11, 12
Chemistry R
Unit: Measurement

OBJECTIVE: To give the student an appreciation of different degrees of precision; to introduce significant figures

MATERIALS AND EQUIPMENT: Square meter stick

PROCEDURE:

Take four measurements of the length of a demonstration desk using a "square" meter stick. The meter stick has a square cross-section and its four sides have, respectively:

Side 1 -- no divisions

Side 2 -- divisions in decimeters only

Side 3 -- divisions in decimeters and centimeters only

Side 4 -- divisions in decimeters, centimeters, and millimeters

Most students can readily understand that Side 4, having more divisions to the meter, can give the experimenters more significant figures in their measurements and more precision than can any of the other sides (instruments). Likewise, Side 3 will produce more precise results than will Side 2, which will produce more precise results than will Side 1.

Evaluation Sample
Grades 10, 11, 12
Chemistry R
Unit: Measurement

WORKSHEET: THE MOLE CONCEPT

The word mole is a word like dozen, gross, or score in that it denotes a particular NUMBER of objects. However, these objects refer to particles of pure substances, i.e. elements, compounds. While dozen denotes twelve objects, the word mole denotes 6.02×10^{23} objects, i.e.:

602,000,000,000,000,000,000,000 objects -- six hundred two sextillion objects.

1. How many atoms in one mole of helium atoms? ______________
2. How many atoms in 0.5 mole of helium atoms? ______________
3. How many atoms in 0.1 mole of helium atoms? ______________
4. One mole of hydrogen atoms consists of 1 gram. What is the mass of two moles of hydrogen atoms? ______________
5. One mole of oxygen atoms has a mass of 16.0 grams. How many moles of oxygen atoms are there in 8.00 grams of oxygen? ______________
6. One mole of argon atoms has a mass of 40.0 grams. How many atoms of argon are there in 20.0 grams of argon? ______________
7. 3.01×10^{23} atoms of sulfur have a mass of 16.0 grams. What is the mass of one mole of sulfur atoms? ______________
8. Which of the following contains more atoms? Why?
   a. 5.00 grams of carbon atoms
   b. 5.00 grams of hydrogen atoms
   c. 5.00 grams of uranium atoms
   d. 5.00 grams of silver atoms
9. What is the mass of one mole of potassium atoms? ______________
10. What is the mass of 1.204×10^{24} atoms of potassium? ______________

866

Evaluation Sample (Cont.)
Grades 10, 11, 12
Chemistry R
Unit: Measurement

Use machine grading card for answers. Use scrap paper as needed. Do not write on this sheet. Use rules for significant figures.

Multiple Choice

1. The sum of 3.42 cm and 14.2 cm is a. 17.52 cm b. 17.62 cm c. 17.6 cm d. 17.5 cm.

2. 40.0 g minus 1.49 g equals a. 38.51 g b. 38.5 g c. 38.0 g d. 39 g

3. 36.1 cm x 0.02 cm equals a. .72 cm^2 b. 0.7 cm^2 c. 0.722 cm^2 d. 0.72 cm^2

4. 81.0 cm^2 ÷ 9.000 cm = a. 729 cm^3 b. 9.00 cm c. 0.111 cm d. 9.0 cm

5. $10^5 \times 10^{-2}$ = a. 10^{-10} b. 10^3 c. 10^{-3} d. 10^{-7}

6. The units for the density of carbon disulfide are a. g/cm^3 b. g/liter c. g/ml^3 d. g/ml.

7. What is the numerical part of the density for a solid if 10.0 grams of it has a volume of 2.50 cm^3? a. 4.00 b. 4.0 c. 0.25 d. .250

8. What is the mass of a solid that has a volume of 50.0 cm^3 and a density of 1.100 g/cm^3? a. 55.0 g b. 5.50 g c. 5.500 g d. 5.55g

9. In ordinary notation, 6.92×10^3 is a. 6.920 g b. 6920 g c. 692000 g d. 0.00692 g.

10. In scientific notation 0.05060 cm is a. 5.060×10^{-2} cm b. 5.060×10^2 cm c. 5.06×10^{-2} cm d. 5.06×10^2 cm.

11. How many sig. fig's are in 10040500 km? a. 3 b. 4 c. 5 d. 6 e. 7

12. 4.0 meters is the length of one side of a box. Its volume is a. 64.0 m^3 b. 64 m^3 c. 4.000 m^3 d. 16.0 m^3. (The box is a cube.)

13. The box in Question 12 above has a capacity of a. 64,000.0 liters b. 6.40×10^2 liters c. 6.40×10^4 liters d. 6.4×10^4 liters.

14. 30.0 grams of Substance Z absorb 18.0 calories in going from 20.0° C. to 40.0° C. The specific heat of the substance is a. 3.00 cal/g-°C b. 108.0 cal/g-°C c. 108 cal/g-°C d. 12.0 cal/g-°C e. 0.0300 cal/g-°C.

15. A student decomposed three different 10.00 g samples of Substance Y in the same way, getting three different amounts of Gas Z as product. He measured: 4.50 g, 4.25 g and 4.00 g of the gas. What was his % error? (Hint: average his three measurements in finding % error.) a. -4.5% b. -4.49% c. .045% d. -.04% (P.S. The accepted value: 4.45 g.)

16. In Question 15 above, the student's experimental error was a. + 0.20 g b. - 0.20 g c. - 4.5% d. - 4.49% e. - 0.10 g.

17. Again referring to Question 15, the average deviation in the student's data was a. + 0.25 g b. - 0.25 g c. 0.17 g d. 4.0% e. 5.9%.

18. Referring to Question 15 again, the % deviation of the measurements was a. 4.0% b. - 4.0% c. 5.9% d. -5.9%.

19. One more reference to Questions 15-18: The student's measurements were a. more accurate than precise b. more precise than accurate c. equally accurate and precise d. there is no way to determine this.

20. 7.00×10^2 cg = ? kg

21. The number of sig. fig's in 0.0303030 g is a. 3 b. 4 c. 5 d. 6.

Evaluation Sample (Cont.)
Grades 10, 11, 12
Chemistry R
Unit: Measurement

Chemistry Math Evaluation Pretest for Students

Possible responses:

a = The problem is worked correctly.

b = The problem has been worked incorrectly.

c = I have studied this type of problem before, but I cannot remember how to work it now. I am not sure if it is right or not.

d = I have never studied this type of problem before.

1. $2/4 = 0.33$ a b c d
2. $1/16 = 0.0625$ a b c d
3. $1/10 = 0.01$ a b c d
4. $30/6 = 0.5$ a b c d
5. $1/3\ (4/5) = 5/8$ a b c d
6. $1/2 \div 1/4 = 2$ a b c d
7. $3/4 + 3/5 = 3/20$ a b c d
8. $1/3 - (1/4) = 1/12$ a b c d
9. $[2\ (4)\ (3)] \div [6\ (2)] = 2$ a b c d
10. $10^2 = 100$ a b c d
11. $\sqrt{25} = 5$ a b c d
12. $2^3 = 6$ a b c d
13. $\sqrt[3]{8} = 3$ a b c d
14. $6^2\ (6^3) = 6^6$ a b c d
15. $9^4 \div 9^3 = 9$ a b c d
16. $a^7 \div a^{10} = a^{-3}$ a b c d
17. $6.9 \times 10^3 = 690$ a b c d

Evaluation Sample (Cont.)
Grades 10, 11, 12
Chemistry R
Unit: Measurement

18. $0.0054 = 5.4 \times 10^{-3}$ a b c d

19. $(2 \times 10^{3})(5 \times 10^{2}) = 10^{6}$ a b c d

20. $5 \times 10^{-3}(3 \times 10^{5}) = 1.5 \times 10^{2}$ a b c d

21. 1594.61 rounded off to four figures is 1595. a b c d

22. The reciprocal of 2 is 1/2. a b c d

23. $6.1\ \text{cm}\ (3.5\ \text{cm}) = 21.35\ \text{cm}^2$
Is this answer written with the correct number of significant figures? a b c d

24. If $X/2.5 = 3/7.5$, then $X = 1$. a b c d

25. Let $T_1 \times N_1 = T_2 \times N_2$
If $T_1 = 5$, $N_1 = 3$ and $T_2 = 6$,
then $N_2 = 2.5$ a b c d

26. If $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$, then

$$T_2 = \frac{P_2V_2}{P_1V_1T_1}$$ a b c d

27. If $1.5/X = 3.0/6.4$, then $X = 3.5$ a b c d

28. If it takes 1 calorie to heat 1 gram of water 1 degrees C., how many calories will be required to heat 3 grams of water 5 degrees C? Answer: 8 calories a b c d

Taken from Hein's Foundations of College Chemistry (study guide)
Peter C. Scott, Dickenson Publishing Co., 1976

Unit Outline
Grades 10, 11, 12
Chemistry R
Unit: Physical States
of Matter

I. The Gas Laws

- A. Kinetic theory
- B. Observed properties of gases
- C. Kinetic-theory description of a gas
- D. Attractive forces between gas molecules
- E. Dependence of gas volume on temperature and pressure
- F. Standard temperature and pressure
- G. Variation of gas volume with pressure: Boyle's Law
- H. Using Boyle's Law
- I. Variation of gas volume with temperature
- J. Kelvin temperature scale
- K. Charles' Law
- L. Use of Boyle's and Charles' Laws combined
- M. Pressure of a gas collected by displacement of mercury
- N. Pressure of a gas collected by water displacement
- O. Behavior of real gases

II. Molecular Composition of Gases

- A. Law of combining volumes of gases
- B. Avogadro's Principle
- C. Molecules of active gaseous elements are diatomic
- D. Molecules of the noble gases are monatomic
- E. Molar volume of a gas
- F. Molecular weight of gases determined experimentally
- G. Chemical problems involving gases
- H. Gas volume-gas volume problems
- I. Mass-gas volume problems
- J. Gases not measured at STP
- K. Gases collected by water displacement
- L. The gas constant
- M. Real gases and the ideal gas

III. Liquids-Solids-Water

- A. Liquids
    1. Properties of liquids
    2. Kinetic-theory description of a liquid
    3. Dynamic equilibrium
    4. Equilibrium vapor pressure
    5. LeChatelier's Principle
    6. Boiling of liquids
    7. Liquefaction of gases
    8. Critical temperature and molecular attraction

B. Solids
   1. Properties of solids
   2. Kinetic-theory description of a solid
   3. Changes of phase involving solids
   4. Amorphous solids
   5. Nature of crystals
   6. Binding forces in crystals

C. Water
   1. Physical properties of water
   2. Structure and properties of water molecules
   3. Chemical behavior of water
   4. Efflorescence
   5. Deliquescence
   6. Deuterium oxide

Suggested Activities
Grades 10, 11, 12
Chemistry R
Unit: Physical States
of Matter

OBJECTIVE: To verify the gas law developed by Boyle

TITLE: "Boyle's Law"

SOURCE: Teacher developed from the Upper Arlington chemistry file

OBJECTIVE: To determine the mass of magnesium needed to replace one gram of hydrogen from a compound

TITLE: "Replacement of Hydrogen by a Metal"

SOURCE: Experiment #15, Exercises and Experiments in Chemistry, pp. 135-136

OBJECTIVE: To determine the molar volume of a gas experimentally

TITLE: "Molar Volume of a Gas"

SOURCE: Experiment #16, Exercises and Experiments in Chemistry, pp. 137-138

OBJECTIVE: To find the percentage of water in crystallized barium chloride

TITLE: "Percentage of Water in a Hydrate"

SOURCE: Experiment #19(a), Exercises and Experiments in Chemistry, pp. 143-144

OBJECTIVE: To show various processes by which crystals are formed and to study the nature of crystals

TITLE: "The Solid State, Crystals and Crystallization"

SOURCE: Experiment #21, Exercises and Experiments in Chemistry, pp. 149-150

Text Materials

Metcalfe, H. Clark; Williams, John E.; and Castka, Joseph F. Modern Chemistry. Holt, Rinehart and Winston, Inc., 1974, pp. 163-222.

Metcalfe, H. Clark; Williams, John E.; and Castka, Joseph F. Exercises and Experiments in Chemistry. Holt, Rinehart and Winston, Inc., 1974, pp. 25-34.

Exemplary Activity
Grades 10, 11, 12
Chemistry R
Unit: Physical States
of Matter

OBJECTIVE: To verify Boyle's Law

In 1661, Robert Boyle described an experiment (in the Register Book of the Royal Society) that he had performed. His experimenting led him to conclude that to reduce the volume of air in a container by one half, the pressure must be doubled. This observation and other similar observations led Boyle and others to formulate a new law: the volume of a gas varies inversely as the pressure (at constant temperature). This is called Boyle's Law. Test this relationship and see if the values you obtain verify this law.

MATERIALS AND EQUIPMENT: 2.5 liter bottle with a one-hole rubber stopper to fit, 30 inch piece of glass tubing, funnel, graduated cylinders, a meter stick, 400 ml beaker, section of rubber tubing, pinch clamp and ring stand with ring, water

PROCEDURE:

Arrange the 2.5 liter bottle, rubber stopper, glass tubing, and funnel as shown in the figure at end of activity.

1. With the bottle on the floor, loosen the stopper and fill the pressure column with water. Use a pinch clamp to keep water from dripping from the tip of the column. Note that the entire column including that below the pinch clamp should be full of water. This is to remove all air from the column. Remove any water that entered the jar while filling the pressure column.

2. Insert the rubber stopper and push it down tightly.

3. Fill the 400 ml beaker with tap water, fill the funnel with water, and by means of the pinch clamp, allow water to enter the bottle, replenishing the supply in the funnel from the beaker, and taking care to allow no air bubbles to form in the water column. Continue this until the water level in the funnel remains stationary.

4. Close the pinch clamp tightly.

5. Measure and record the distance in mm from the floor to the bottom of the meniscus of the water in the funnel.

6. Remove the water column from the bottle, keeping the pinch clamp closed.

7. Set the bottle on the desk, measure and record the distance in mm from the desk top to the bottom of the meniscus of the water in the bottle.

8. By means of a graduated cylinder, measure and record the volume of the water in the bottle.

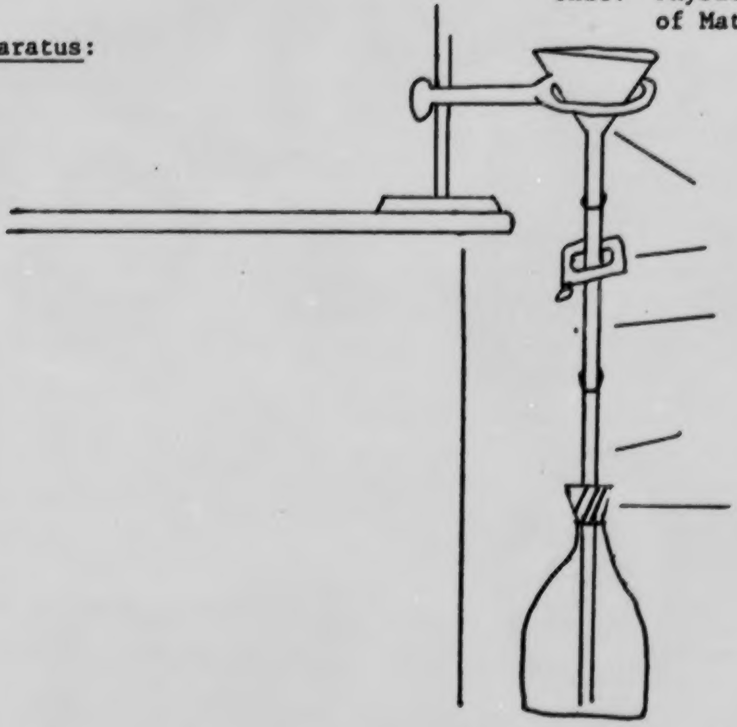
9. Record the total volume of the bottle measured to the bottom of the stopper.

10. Lower the position of the funnel about 10 cm. and repeat the entire procedure, recording data in column II.

Data:	I	II
1) Distance from floor to funnel meniscus	______	______
2) Distance from floor to bottle meniscus	______	______
3) Volume of bottle to bottom of stopper	______	______
4) Volume of water in bottle at end of exercise	______	______
5) Barometric pressure in mm Hg	______	______ mm
6) Height of water column in mm (line#1-line #2)	______	______
7) Water column as mm Hg (density of Hg = 13.5 grams/ cm^3) (Water column in mm/13.5 = water column as mm of Hg)	______	______ mm
8) Total pressure with water column as mm of Hg (lines #5 and #7)	______	______ mm
9) Measured gas volume under increased pressure (line #3-line #4)	______	______
10) Theoretical volume by Boyle's Law (Theoretical volume = bottle volume x pressure ratio)	______	______
11) Error (difference between lines #9 and #10)	______	______
12) Error as percent of theoretical volume	______	______

*Teacher developed unit

Apparatus:



Evaluation Sample
Grades 10, 11, 12
Chemistry R
Unit: Physical States
of Matter

Reference:

Metcalfe, H. Clark; Williams, John E.; and Castka, Joseph F. Tests #8, 9, 10, Tests in Chemistry. Holt, Rinehart, and Winston, Inc., 1974.

Unit Outline
Grades 10, 11, 12
Chemistry R
Unit: Solutions and Their Properties

I. The Solution Process

   A. Solutions and suspensions
   B. Types of solutions
   C. Solvents are selective
   D. Hydrogen bonds and properties of solvents
   E. Solvent equilibrium
   F. Influence of pressure on solubility
   G. Temperature and solubility
   H. Increasing the rate of dissolving
   I. Dissolving mechanisms
   J. Heat of solution
   K. Concentration of solutions
   L. Freezing-point depression of solvents
   M. Boiling-point elevation of solvents
   N. Molecular weights of solutes

II. Ionization

   A. Conductivity of solutions
   B. Electrolytes as solutes
   C. Behavior of electrolytes explained
   D. Structure of electrovalent compounds
   E. Hydration of ions
   F. Some covalent compounds ionize
   G. Strength of electrolytes
   H. Ionization of water
   I. Substances that do not ionize
   J. Effects of electrolytes on the freezing and boiling points of solvents
   K. The degree of ionization

III. Acids, Bases, and Salts

   A. Acids
      1. Importance of acids
      2. Industrial acids
      3. Aqueous acids
      4. Modern definition of acids
      5. Properties of aqueous acids
      6. Naming of aqueous acids
      7. Acid anhydrides
   B. Bases
      1. The nature of bases
      2. Characteristics of hydroxides
      3. Basic anhydrides
      4. Hydroxides and periodic trends
      5. Relative strengths of acids and bases

- C. Salts
  - 1. Nature of salts
  - 2. Salt-producing reactions
  - 3. Naming salts

IV. Acid-Base Titration and pH

- A. Titration
  - 1. Molar solutions
  - 2. Chemical equivalents
  - 3. Normal solutions
  - 4. Ion concentration in water
- B. pH
  - 1. The pH of a solution
  - 2. pH calculations
  - 3. Acid-base titration
  - 4. Indicators in titrations

Suggested Activities
Grades 10, 11, 12
Chemistry R
Unit: Solutions and Their Properties

OBJECTIVE: To show how the nature of the attractive forces between molecules determines and helps to explain the solution process and the selectivity of solvents

TITLE: "Solution and Molecular Polarity"

SOURCE: Exercises and Experiments in Chemistry

OBJECTIVE: To prepare a chemical indicator; to prepare a color chart for an indicator; to determine the pH of a number of solutions using the indicator and its chart; to learn the relationship between the pH and hydrogen ion concentration of a solution

TITLE: "Preparation and Use of a Chemical Indicator"

SOURCE: Laboratory Experiments for Foundations of Chemistry

OBJECTIVE: To determine the percentage of acetic acid in a sample of vinegar; to learn and apply the concepts of molarity

TITLE: "Acid-Base Titration"

SOURCE: Modified exercise from Laboratory Experiments for Foundations of Chemistry

Laboratory technique taught -- the titration technique in volumetric analysis

Resources
Grades 10, 11, 12
Chemistry R
Unit: Solutions and Their Properties

Text Materials

Metcalfe, H. Clark; Williams, John E.; and Castka, Joseph F. Modern Chemistry. Holt, Rinehart and Winston, Inc., 1974, pp. 223-305.

Lab Materials

Metcalfe, H. Clark; Williams, John E.; and Castka, Joseph F. Exercises and Chemistry. Holt, Rinehart and Winston, Inc., 1974, pp. 145-147.

Toon, Ernest R., and Ellis, George L. Laboratory Experiments for Foundations of Chemistry. Holt, Rinehart and Winston, Inc., 1968, pp. 126-128, 140-143.

Evaluation Materials

Metcalfe, H. Clark; Williams, John E.; and Castka, Joseph F. Tests in Chemistry. Holt, Rinehart and Winston, Inc., 1974, tests number 11, 12, 13, and 14.

Exemplary Activity
Grades 10, 11, 12
Chemistry R
Unit: Solutions and Their
Properties

Reference:

Toon, Ernest R., and Ellis, George L. "Preparation and Use of a Chemical Indicator," Laboratory Experiments for Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968, pp. 126-127.

Evaluation Sample
Grades 10, 11, 12
Chemistry R
Unit: Solutions and Their
Properties

Reference:

Metcalfe, H. Clark; Williams, John E.; and Castka, Joseph F. Tests #11, 12, 13, 14, Tests in Chemistry. Holt, Rinehart, and Winston, Inc., 1974.

Unit Outline
Grades 10, 11, 12
Chemistry R
Unit: Chemical Reactions

I. Reaction Energy and Reaction Kinetics

- A. Introduction
- B. Energy of reaction
    - 1. Heat of reaction
    - 2. Heat of formation
    - 3. Stability and heat of formation
    - 4. The heat of combustion
    - 5. The driving force of reactions
- C. Reaction mechanisms
    - 1. Activation energy
- D. Reaction rates
    - 1. Rate influencing factors

II. Chemical Equilibrium

- A. Reversible reactions
- B. Equilibrium, a dynamic state
- C. The equilibrium constant
- D. Factors that disturb equilibrium
- E. Reactions that run to completion

III. Oxidation-Reduction Reactions

- A. Oxidation and reduction processes
- B. Oxidation and reduction occur simultaneously
- C. Oxidizing and reducing agents
- D. Electrochemical reactions
- E. Electrolysis of water
- F. Electroplating
- G. Lead storage battery

Suggested Activities
Grades 10, 11, 12
Chemistry R
Unit: Chemical Reactions

OBJECTIVE: To show how the rate of a particular chemical reaction may be measured; to study the effect of changing the conditions of concentration and temperature on the rate of reaction

TITLE: "Rate of Chemical Reaction"

SOURCE: Experiment #35, Exercises and Experiments in Chemistry, pp. 195-197

OBJECTIVE: To investigate the decomposition of hydrogen peroxide: (a) the decomposition products; (b) the thermal nature of the reaction; (c) the course of the catalyzed and uncatalyzed reaction

TITLE: "Course of a Chemical Reaction: Catalysis"

SOURCE: Experiment #36, Exercises and Experiments in Chemistry, pp. 199-200

OBJECTIVE: To test the water solutions of some salts to discover which are not neutral and to explain why this phenomenon occurs

TITLE: "Hydrolysis"

SOURCE: Experiment #39, Exercises and Experiments in Chemistry, pp. 207-208

OBJECTIVE: To construct several electrochemical cells and study their performance

TITLE: "Electrochemical Cells, Half-Cell Reactions"

SOURCE: Experiment #43(a), Exercises and Experiments in Chemistry, pp. 215-217

Resources
Grades 10, 11, 12
Chemistry R
Unit: Chemical Reactions

Text Materials

Metcalfe, H. Clark; Williams, John E.; and Castka, Joseph F. Modern Chemistry. Holt, Rinehart and Winston, Inc., 1974.
Chapter 19, sections 19.1-19.5, 19.7, 19.10, 19.12
Chapter 20, sections 20.1-20.5
Chapter 21, sections 21.1, 21.2, 21.4, 21.6, 21.7, 21.9, 21.10

Metcalfe, H. Clark; Williams, John E.; and Castka, Joseph F. Exercises and Experiments in Chemistry. Holt, Rinehart and Winston, Inc., 1974, pp. 59-70.

Exemplary Activity
Grades 10, 11, 12
Chemistry R
Unit: Chemical Reactions

Reference:

Metcalf, H. Clark; Williams, John E.; and Castka, Joseph F. "Course of a Chemical Reaction: Catalysis," Exercises and Experiments in Chemistry. Holt, Rinehart, and Winston, Inc., 1974, pp. 199-200.

Evaluation Sample
Grades 10, 11, 12
Chemistry R
Unit: Chemical Reactions

Reference:

Metcalfe, H. Clark; Williams, John E.; and Castka, Joseph F. Tests #18, 19, 20, Tests in Chemistry. Holt, Rinehart, and Winston, Inc., 1974.

Unit Outline
Grades 10, 11, 12
Chemistry R
Unit: Descriptive Chemistry

I. Elements Particularly Emphasized

- A. Hydrogen
  1. Abundance in universe
  2. Atomic energy production by fusion in stars and hydrogen bomb
  3. Importance
  4. Properties
  5. Preparation
- B. Oxygen
  1. Abundance in continental crust and biosphere
  2. Importance
  3. Properties
  4. Preparation
  5. Allotropic forms
- C. Carbon
  1. Abundance and importance
  2. Characteristics of carbon atoms
  3. Allotropic forms of carbon
  4. Diamond
  5. Graphite
  6. Uses of graphite
  7. Destructive distillation
  8. Coke
  9. Charcoal
  10. Boneblack
  11. Activated charcoal
  12. Other forms of amorphous carbon
- D. Sulfur
  1. Occurrence of sulfur
  2. The production of sulfur
  3. Physical properties of sulfur
  4. Allotropic forms of sulfur
  5. Chemical properties of sulfur
  6. Uses of sulfur

II. Organic Chemistry (time permitting)

- A. Introduction to polymers
- B. Introduction to esters

III. Descriptive Chemistry from Chemical Periodicals

- A. Student readings from general topics on elements, atomic structure, biography
- B. Student-written reports on articles and short topics

IV. Career Education in Science Areas

Suggested Activities
Grades 10, 11, 12
Chemistry R
Unit: Descriptive Chemistry

OBJECTIVE: To acquire firsthand experience with hydrogen; to study its preparation and properties

TITLE: "A Study of Hydrogen"

SOURCE: Teacher developed departmental material. Sources unknown.

OBJECTIVE: To furnish firsthand experience with the preparation and typical reactions of oxygen

TITLE: "A Study of Oxygen"

SOURCE Teacher developed departmental material. Sources unknown.

OBJECTIVE: To become familiar with the properties of many of the allotropic forms of carbon; to prepare sugar charcoal by the thermal decomposition of sucrose; to be introduced to the reduction of metals from their ores

TITLE: "Some Properties of Carbon"

SOURCE: Teacher developed departmental material. Sources unknown.

OBJECTIVE: To become familiar with a typical nonmetal and the properties of its allotropic forms; to become familiar with some of its reactions

TITLE: "A Study of Sulfur"

SOURCE: Teacher developed departmental material. Sources unknown.

OBJECTIVE: To prepare an amorphous solid and to study the effects of various impurities on such properties as color, odor, and taste.

TITLE: "The Solidification of a Supersaturated Aqueous Solution of a Complex B-Glycosidic-Linked Polysaccharide" (Xmas Candy Lab)

SOURCE: Departmental material, previously from Worthington High School.

Resources
Grades 10, 11, 12
Chemistry R
Unit: Descriptive Chemistry

Text Materials

Metcalfe, H. Clark; Williams, John E.; and Castka, Joseph F. Modern Chemistry. Holt, Rinehart and Winston, Inc., 1974, pp. 32-35, 311-317, 573-577, 625-626.

Lab Materials

Teacher developed departmental labs. (Available upon request.)

Demonstration Materials (for Organic Chemistry section, time permitting)

Toon, Ernest R., and Ellis, George L. Laboratory Experiments for Foundations of Chemistry. Holt, Rinehart and Winston, Inc., 1968, pp. 189-191, 197-200.

Periodicals

Chemistry. American Chemical Society, 1155 Sixteenth Street, N.W., Washington D.C., 1967 to date. UAHS Learning Center.

Evaluation Materials

Metcalfe, H. Clark; Williams, John E.; and Castka, Joseph F. Tests in Chemistry. Holt, Rinehart and Winston, Inc., 1974, tests number 15 and 27.

Dull, Charles E., and Castka, Joseph F. Tests in Chemistry. Holt, Rinehart and Winston, Inc., 1958, test number 4.

Student-written summaries of articles from Chemistry magazine.

Career Education Materials

Careers Related to Science. Denoyer-Geppert Audio-Visuals, 1977. A three-part filmstrip and cassette-taped series of informative presentations, complete with a program supplemental booklet. Departmental. Series presents testimonials from many employees in science-related fields whose science education background varies from minimal to very extensive.

Self-evaluation device for students, designed to enhance career choices.

Exemplary Activity
Grades 10, 11, 12
Chemistry R
Unit: Descriptive Chemistry

OBJECTIVE: The purpose of this exercise is to give you some firsthand experience with the preparation and typical reactions of oxygen, the most abundant element on earth. This element, for many reasons, is one of the most important to man. It combines with almost all the other elements in a process called oxidation; if this process occurs rapidly enough to produce light, we call it combustion. Some of the common uses of oxygen include combining with fuels in torches, reviving patients in hospitals and elsewhere, and purifying water used for consumption. Oxygen is a substance produced along with simple sugars in photosynthesis in green plants, and is a necessary substance in the process of respiration in all living organisms. Oxygen occurs in two allotropic forms: one is "normal" oxygen (O_2), and the other is called ozone (O_3).

MATERIALS AND EQUIPMENT: See Procedure

PROCEDURE:

1. Assemble the apparatus as show in the diagram.

2. Mix about 10 grams of potassium chlorate ($KClO_3$) and about 4 grams of manganese dioxide (MnO_2) on a piece of notebook paper.

3. Empty the mixture into a test tube and attach the stopper and delivery tube.

4. Fill the pan 1/2 full of tap water and allow the overflow to extend over the waste trough.

5. Heat the tube gently, beginning at the top of the mixture and moving the flame down the tube as the oxygen is evolved (why?).

6. Collect 5 bottles of gas. As the bottles fill, place them mouth upward (why?) on the benchtop with glass plates on top.

7. When you have finished, remove the delivery tube from the water and then stop heating the mixture (why?).

8. Insert a glowing splint into a bottle of oxygen several times.

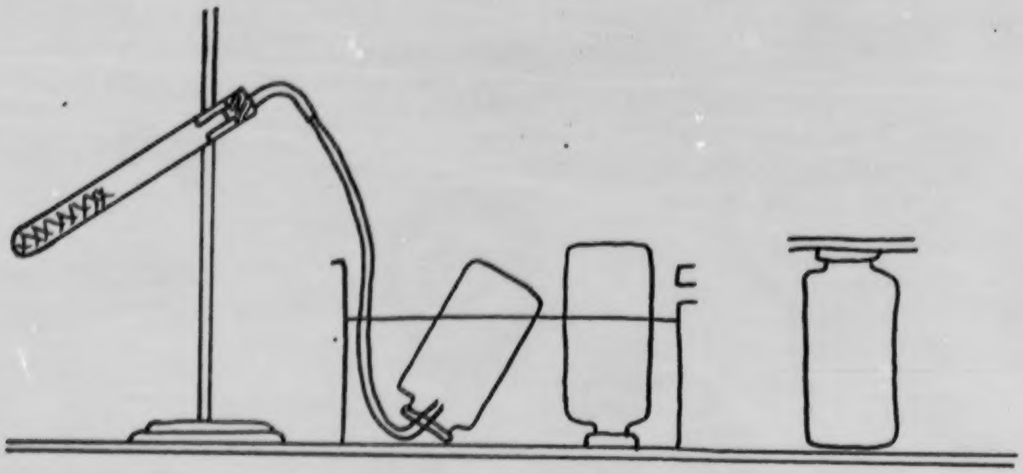
9. Secure a combustion spoon from the stockroom. Place a small bit of phosphorus in the spoon, ignite it in a Bunsen flame, and lower it into a bottle of oxygen. Take the bottle of white smoke to the fume hood and release it. (A smoke is not a gas, it is a solid; all gases are transparent.)

10. Cool the spoon, and then place a small bit of sulfur in it. Ignite the sulfur in a Bunsen flame, and lower it into a bottle of oxygen.

11. Remove the spoon, add 20 ml of distilled water to the bottle, cover with your hand, and shake vigorously. Add a strip of blue litmus paper and draw your conclusions.

12. Cool the spoon, and place a small piece or two of wood charcoal in it. Hold the spoon in the tip of the Bunsen flame until it glows red. Immediately lower the spoon into a bottle of oxygen. When the charcoal stops burning, remove the spoon and add about 10 ml of clear limewater ($Ca(OH)_2$) to the bottle and note the result after shaking vigorously.

13. Using your crucible tongs, heat a small quantity of steel until it glows brightly. Wad the steel wool up into a tight ball before heating. By bringing a bottle of oxygen right up to the glowing iron, quickly transfer it into the bottle. The iron must be above its kindling temperature when it contacts the oxygen.



Suggested Discussion Topics

1. A diagram of the apparatus used to produce oxygen gas
2. The chemical equation, in both words and symbols, for the reaction that produced oxygen in this exercise
3. An explanation of the role of a catalyst in a chemical reaction
4. An explanation of the role of oxygen in combustion

5. The chemical equations, in words and symbols, for:
    a. the combustion of phosphorus
    b. the combustion of sulfur
    c. the reaction between the oxide of sulfur and water
    d. the combustion of carbon
    e. the reaction between carbon dioxide and limewater
    f. the combustion of iron

6. A list of the important physical properties of oxygen, both from this exercise and from references

7. The differences between oxygen and ozone: molecular structure, physical properties, behavior, production in lab, occurrence in nature, and possible uses

Evaluation Sample
Grades 10, 11, 12
Chemistry R
Unit: Descriptive Chemistry

References:

Dull, Charles E., and Castka, Joseph F. Tests #4 and 15, Tests in Chemistry. Holt, Rinehart, and Winston, Inc., 1958.

Metcalfe, H. Clark; Williams, John E.; and Castka, Joseph F. Test #27, Tests in Chemistry. Holt, Rinehart, and Winston, Inc., 1974.

Unit Outline
Grades 10, 11, 12
Chemistry S
Unit: Fundamental Concepts

I. The Science of Chemistry

- A. Introduction
  1. Chemistry: a physical science
  2. Keystones of modern chemistry
  3. Methods of science
- B. Matter and energy
  1. Concept of matter
  2. Mass and weight
  3. Density of matter varies
  4. Three phases of matter
  5. Properties of matter
  6. Concept of energy
  7. Forms of energy
  8. Conservation of matter and energy
- C. Measurements in chemistry
  1. Metric system
  2. Units of the metric system
  3. Factor label system, dimensional analysis
  4. Temperature and heat
  5. Measuring temperature
  6. Uncertainty in measurements
  7. Significant figures
  8. Exponential notation
  9. Operations with significant figures
  10. Operations with units

II. Matter and Its Changes

- A. Composition of matter
  1. Three general classes of matter
  2. Mixtures
  3. Substances include compounds and elements
  4. The known elements
  5. The earth's elemental composition
  6. Two general classes of elements
  7. Chemical symbols
  8. Significance of a symbol
  9. Compounds differ from mixtures
  10. Law of definite composition
  11. Common examples of mixtures and compounds
- B. Changes in matter
  1. Physical changes
  2. Chemical changes
  3. Chemical reactions involve energy
  4. Reaction tendencies
  5. Nuclear changes

Suggested Activities
Grades 10, 11, 12
Chemistry S
Unit: Fundamental Concepts

OBJECTIVE: To learn names and some functions of basic lab equipment

TITLE: "Getting Organized"

SOURCE: Teacher Developed

OBJECTIVE: To learn names of parts of burner, how to adjust burner, and characteristics of luminous and nonluminous flames

TITLE: "Construction and Operation of the Bunsen Burner"

SOURCE: Teacher developed

OBJECTIVE: To learn to cut glass tubing, to bend glass tubing correctly, to firepolish glass, and to make pipettes

TITLE: "The Manipulation of Glass Tubing"

SOURCE: Teacher developed

OBJECTIVE: To construct a gas generator, to identify three functions of a thistle tube in a generator, and to learn the outcomes of pressure differences inside and outside the generator

TITLE: "The Gas Generator"

SOURCE: Teacher developed

OBJECTIVE: To learn to construct and use a filter setup

TITLE: "Filtration and Evaporation"

SOURCE: Teacher developed

OBJECTIVE: To gain skill in making accurate measurements, to become familiar with limitations of measuring devices, and to become more aware of sources of experimental error

TITLE: "Measurement -- The Basis of Quantitative Chemistry"

SOURCE: Toon and Ellis. Laboratory Experiments for Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968.

OBJECTIVE: To separate components of a physical mixture (solution), and to practice the techniques of filtration, evaporation, and decantation

TITLE: "Analysis of a Mixture"

SOURCE: Toon and Ellis. Laboratory Experiments for Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968.

OBJECTIVE: To construct a calorimeter, and to give meaning to concepts of heat exchange and specific heat

TITLE: "Energy Transfer and Temperature Change"

SOURCE: Toon and Ellis. Laboratory Experiments for Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968.

Resources
Grades 10, 11, 12
Chemistry S
Unit: Fundamental Concepts

Text Materials

Nebergall, William H. General Chemistry. Heath, 1976.

Toon and Ellis. Laboratory Experiments for Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968.

Film Loops -- High School Learning Center

Archimedes' Principle

Conservation of Mass

Density

Mass, Weight, Volume

Cassette Tapes -- High School Learning Center

Heat Transfer in Chemical Reactions (tape #11)

Mathematics Review (tape #1)

Problem-Solving Modules for General Chemistry

Worksheets

Calorimetry

Density

Exponential Numbers

Fundamental Concepts

Significant Digits

Temperature Scales

Exemplary Activity
Grades 10, 11, 12
Chemistry S
Unit: Fundamental Concepts

OBJECTIVE: To construct a gas generator, to identify three functions of a thistle tube in a generator, and to learn the outcomes of pressure differences inside and outside the generator

MATERIALS AND EQUIPMENT: See Procedure

BACKGROUND: The gas generator, as its name implies, is a frequently used setup when a gaseous substance is to be produced and removed for use or study. It is efficient, but it is also a bit tricky unless you are aware of its habits and peculiarities; hence this study. The gas you use will be water vapor, but all other gases will behave just as the water vapor does in this case.

PROCEDURE:

1. Using your 250 ml Erlenmeyer flask, a two-hole rubber stopper to fit, and the 90-degree glass bend made in the previous exercise, construct the apparatus shown in the diagram on the next page. The thistle tube should clear the bottom of the flask by approximately 5 mm. The thistle tube and glass bend should have firepolished ends. Glycerine or saliva applied to glass tubes makes insertion into rubber stoppers easier. The thistle tube should be grasped close to the stopper when inserting it.

2. Test the apparatus to make sure that it is gas-tight (doesn't leak). Pour 50 ml of distilled water into the flask through the thistle tube. Then blow gently into the rubber tubing until the water rises into the bell of the thistle tube. Pinch the tube (double it over) between your fingers. If the water level doesn't fall for 15 seconds or so, the apparatus is gas-tight.

3. If the generator is not gas-tight, make it so. Areas to check include the thistle tube, the glass bend, the rubber tube, and the stopper.

4. Heat the flask until the water comes to a vigorous boil. Then observe where the gas is leaving the flask.

5. Remove the burner and raise the thistle tube until the bottom of the stem clears the water. Replace the burner and bring the water to an active boil again. Now observe where the gas is leaving the flask.

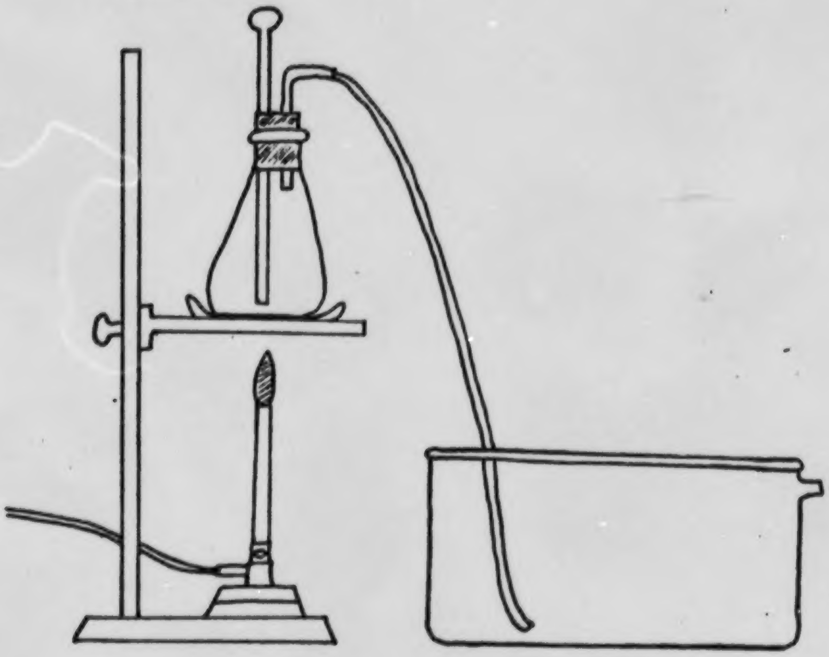
6. Lower the thistle tube again and bring the water to a boil. While it is boiling, pinch the delivery tube between your fingers and watch what happens. What would happen if only the glass bend and a one-hole stopper had been used? (Some optimistic amateurs attempt to build a generator that way. But only once.)

7. Submerge the end of the delivery tube in the water in the enameled pan. Boil the water vigorously for a couple of minutes, then remove the burner and observe what happens as the water vapor cools. Construct a theory to explain what is happening.

8. To test your theory, boil the water again, remove the burner, and quickly insert a solid stopper into the top of the thistle tube. Observe what happens this time (this can be speeded up by fanning the flask with your notebook to cool it faster).

Suggested discussion topics:

1. The overall purpose of a gas generator setup
2. The reason why the thistle tube should be inserted into the liquid in the flask
3. What happens when the delivery tube is blocked
4. What happens when the thistle tube is blocked
5. How the thistle tube serves as a:
    - convenience
    - safety device (2 ways)
    - warning device



Evaluation Sample
Grades 10, 11, 12
Chemistry S
Unit: Fundamental Concepts

Chemistry Quiz -- 18 points

1. The reading on the hydrometer is ________________ (3 sig figs).
2. The reading on the balance is ________________ grams (to nearest centigram).
3. A block of ______________ having dimensions of __________ x __________ x ______________ would occupy a volume of ____________.
4. If the specific gravity of a liquid is ______________, what would ______________ ml of this liquid weigh?
5. A solid object was submerged in water, and the following data was taken:

   mass of object in air = ______________ grams

   mass of object in water = ______________ grams

   What is the density of this object?

Unit Outline
Grades 10, 11, 12
Chemistry S
Unit: Classification of
Elements

I. Chemical Change
(See Fundamental Concepts Unit)

II. Structure

A. Atomic structure
  1. Particles of matter
  2. The atomic theory
  3. The structure of the atom
  4. The characteristics of electrons
  5. The nucleus of the atom
  6. Hydrogen atoms
  7. Helium atoms
  8. Lithium atoms
  9. Other atoms of the second series
  10. The atoms of the third series
  11. Atomic mass
  12. The Avagadro number and the mole
  13. Atomic weight

B. Arrangement of electrons in atoms
  1. The nucleus and moving electrons
  2. Electromagnetic radiation
  3. Spectra of atoms
  4. Wave-mechanics concept of an atom
  5. Quantum numbers
  6. Electron configuration of atoms of first three series
  7. Atoms of the fourth series
  8. Atoms of the fifth series
  9. Atoms of the sixth series
  10. Atoms of the seventh series

III. The Periodic Table

A. The periodic law
  1. Mendeleev's periodic table
  2. Mosley determines atomic numbers
  3. The periodic law
  4, Arrangement of modern periodic table
  5. Size of atoms: a periodic property
  6. Ionization energy
  7. Ionization energy to remove successive electrons
  8. Electron affinity
  9. Value of the periodic table
  10. Electronegativity

IV. Bonding

A. Chemical bonds
   1. Elements form compounds
   2. Valence electrons and chemical bonds
   3. Ionic bonding (electrovalence)
   4. Energy change in ionic bonding
   5. Oxidation and reduction
   6. Formation of magnesium bromide from its elements
   7. Elements with several oxidation numbers
   8. Relative sizes of atoms and ions
   9. Covalent bonding (covalence)
   10. Covalent bonding of unlike atoms
   11. Resonance
   12. Hybridization
   13. More about particles of matter
   14. Size of molecules
   15. Electronegativity
   16. Electronegativity difference and chemical bonding
   17. Molecular polarity
   18. Polyatomic ions
   19. Summary of oxidation-number rules
   20. Metallic bonding
   21. Van der Waal's forces
   22. Hydrogen bonding
   23. Shapes of molecules -- prediction of

Suggested Activities
Grades 10, 11, 12
Chemistry S
Unit: Classification of
Elements

OBJECTIVE: To gain insight into the origin of emission lines, and to observe emission spectra of certain selected elements and calculate their wavelengths

TITLE: "Electron Transitions in Atoms"

SOURCE: Toon and Ellis. Laboratory Experiments for Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968.

OBJECTIVE: To apply probability in drawing a physical analogy to an orbital and in increasing understanding of wave mechanical atoms

TITLE: "Locating an Electron in an Atom by Analogy"

SOURCE: Toon and Ellis. Laboratory Experiments for Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968.

OBJECTIVE: To become familiar with the periodicity of electron configuration and atomic properties, and to predict the properties of elements by studying properties of neighboring elements

TITLE: "Significance and Use of the Periodic Table"

SOURCE: Toon and Ellis. Laboratory Experiments for Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968.

OBJECTIVE: To determine general trends that occur in metallic and nonmetallic characteristics down a group or across a period of the periodic table

TITLE: "Periodicity in the Properties of Some Representative Elements"

SOURCE: Teacher developed

Resources
Grades 10, 11, 12
Chemistry S
Unit: Classification of
Elements

Text Materials

Nebergall, William H. General Chemistry. Heath Publishing Co., 1976.

Toon and Ellis. Laboratory Experiments for Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968.

Film Loops -- High School Learning Center

Absorption Spectra

Mass Spectrometer

Films

Chemical Families

Hydrogen Atom (As Viewed by Quantum Mechanics)

Ionization Energy

Cassette Tapes -- High School Learning Center

Quantum Mechanical Structure and Properties of Atoms (tape #18)

Writing Lewis Structures for Atoms and Molecules (tape #2)

Worksheets

Atomic Structure

Exemplary Activity
Grades 10, 11, 12
Chemistry S
Unit: Classification of
Elements

OBJECTIVE: To determine general trends that occur in metallic and nonmetallic characteristics down a group or across a period of the periodic table

MATERIALS AND EQUIPMENT: See Procedure

BACKGROUND: By observing the properties of one or two elements in a given group of the periodic table, we are often able to predict some of the properties of the other members of the group. In this exercise you will investigate the properties and behavior of some of the elements in several of the vertical groups of the periodic table. You will first classify the elements you studied as either metallic or nonmetallic. You will then use the rater limited evidence to determine general trends that occur in metallic and nonmetallic characteristics as you go down a group or across a period of the periodic table. In addition, you will try to predict the behavior of other elements in the table.

PROCEDURE:

1. Carefully examine samples of the elements that have been provided. For each, note (1) the physical state at room temperature, (2) the color, (3) the luster, (4) the general appearance (metallic, powdery, waxy). You might want to use a table. Classify each element as a metal or a nonmetal on the basis of these physical characteristics (properties).

2. Put about 5 ml of dilute hydrochloric acid (HCl) in a clean test tube. Cut a piece of magnesium ribbon about 5 cm long.

3. Drop the magnesium ribbon into the acid and have your partner immediately hold a lighted splint at the mouth of the test tube. Repeat the procedure, this time thrusting a glowing splint into the test tube. The gas produced is hydrogen. Record the properties of the product and note any energy changes.

4. Repeat the procedure in #3 using a small piece of calcium.

5. Dissolve a small quantity of magnesium oxide in water. Test the solution with litmus paper, which turns red in acidic solution and blue in basic solution.

6. Repeat the procedure in #5 using a small quantity of calcium oxide instead of magnesium oxide.

7. In three separate test tubes place respectively 2 ml of sodium chloride (NaCl), sodium bromide (NaBr), and sodium iodide (NaI) solutions. To each test tube add a drop of a silver nitrate solution. Record your observations. The metallic binary compounds of the halogens are called halogenides.

8. Cut a piece of sodium the size of a grain of rice and examine the freshly cut surfaces. Record your observations. Drop the small piece into a 250 ml beaker that is half-filled with water containing several drops of phenolphthalein. Quickly cover the beaker with your wire gauze.

9. Repeat the procedure in step 8, using a small piece of potassium. Note the relative reactivities of sodium and potassium. The gas evolved in both reactions is hydrogen.

10. Place a small amount of red phosphorus (size of a rice grain) in a clean combustion spoon and ignite in a Bunsen flame. Lower the spoon into a wide-mouth bottle containing 5-10 ml of water (distilled variety). Cover as completely as possible with a glass plate. After burning has ceased, remove the spoon and vigorously shake the contents of the bottle. The white smoke is an oxide of phosphorus. Test the solution with litmus.

11. Repeat the procedure in step 10, using sulfur instead of red phosphorus.

Suggested Discussion Topics:

1. Draw an abbreviated periodic table showing the elements that you have studied in this lab. Draw two arrows, one below and one to the left of the table, and label the arrows to show increase in metallic properties.

2. Draw another arrow below the table and label it to show increase in acidic nature of oxides. Explain the relationship between type of element and nature (acidic or basic) of oxide formed.

3. In general, explain where the nonmetallic elements are located in the periodic table.

4. Explain, from the evidence collected in this exercise, whether metallic elements form basic or acidic oxides.

5. Write a balanced chemical equation for the reaction of calcium with hydrochloric acid.

6. Make the following predictions:

   a. Whether or not barium, element number 56, would react with hydrochloric acid. If so, write the balanced chemical equation.

   b. Whether cesium, element number 55, would be more or less reactive than potassium.

   c. Write the chemical equation for the reaction between calcium oxide and water.

   d. Whether the reaction between the oxide of strontium, element number 38, and water would be acidic or basic.

   e. What would the color and solubility of silver astatide be?

   f. Write the formulas for hydrobromic acid and gallium oxide. Gallium is element number 31.

   g. Sulfur forms the following compounds: sulfur dioxide, SO_2; hydrogen sulfide, H_2S; and sulfuric acid, H_2SO_4. Write the names and formulas for analogous compounds that might be formed by tellurium, element number 52.

Reference:

Toon and Ellis. 7-1, "Electron Transitions in Atoms," Laboratory Experiments for Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968, pp. 80-82.

Evaluation Sample
Grades 10, 11, 12
Chemistry S
Unit: Classification of
Elements

Chemistry Quiz

1. Calculate the ____________ of a wave that has a wavelength of ____________________ Å.

2. Name a region of the electromagnetic spectrum that has a ______________ than the visible region.

   Answer: ________________________________

3. Refraction and diffraction both result in separation of different wavelengths of electromagnetic radiation. Explain how these two phenomena are different.

4. Discuss energy absorption and emission by electrons in atoms.

5. Calculate the atomic mass of the element given the masses of the following isotopes and their respective percentages of any naturally occurring sample.

Unit Outline
Grades 10, 11, 12
Chemistry S
Unit: Chemical Formulas
and Equations

I. Chemical Composition

- A. Table of ions and their charges
- B. Writing chemical formulas
- C. Writing the formulas for other compounds
- D. Naming compounds from their formulas
- E. Significance of chemical formulas
- F. Molecular weight
- G. Formula weight of a compound
- H. Percentage composition of a compound
- I. Law of definite composition and atomic theory
- J. Law of multiple proportions
- K. Mole concept
- L. Determining the empirical formula of a compound

II. Chemical Equations

- A. Formula equations
- B. Factors in equation writing
- C. Procedure in writing equations
- D. General types of chemical reactions
- E. Six kinds of decomposition reactions
- F. Four kinds of replacement reactions
- G. Many reactions are reversible
- H. The activity series of the elements
- I. Stoichiometric relations
- J. Mole relations of reactants and products
- K. Mole method of solving mass-mass problems
- L. Excess-deficit relationships of reactants in equations

Suggested Activities
Grades 10, 11, 12
Chemistry S
Unit: Chemical Formulas and
Equations

OBJECTIVE: To learn relationships among moles, grams, molecules, and atoms

TITLE: "The Mole Concept"

SOURCE: Toon and Ellis. Laboratory Experiments for Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968.

OBJECTIVE: To determine a percentage of one element (Ag) in an alloy

TITLE: "Percentage of Silver in a Silver Alloy"

SOURCE: Toon and Ellis. Laboratory Experiments for Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968.

OBJECTIVE: To synthesize a compound, compare its properties to that of its elements, and determine the percentages of elements in a compound

TITLE: "Synthesis and Composition of a Compound"

SOURCE: Toon and Ellis. Laboratory Experiments for Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968.

OBJECTIVE: To determine experimentally a mole ratio in a reaction

TITLE: "Mole Relationships in a Chemical Reaction"

SOURCE: Toon and Ellis. Laboratory Experiments for Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968.

OBJECTIVE: To apply mass ratios in the determination of percentage yield of a product

TITLE: "Mass Relationships in Chemical Reactions"

SOURCE: Toon and Ellis. Laboratory Experiments for Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968.

Resources
Grades 10, 11, 12
Chemistry S
Unit: Chemical Formulas and Equations

Text Materials

Nebergall, William H. General Chemistry. Heath Publishing Co., 1976.

Toon and Ellis. Laboratory Experiments for Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968.

Cassette Tapes -- High School Learning Center

Calculations From Chemical Equations I: Stoichiometry (tape #5)

Calculations From Chemical Equations II: Factors and Percentage Yields (tape #6)

Empirical Formulas and Percentage Composition (tape #4)

The Mole and Molar Weight (tape #3)

Exemplary Activity
Grades 10, 11, 12
Chemistry S
Unit: Chemical Formulas and
Equations

Reference:

Toon and Ellis. 4-4, "Mole Relationships in a Chemical Reaction," Laboratory Experiments for Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968, pp. 55-56.

Evaluation Sample
Grades 10, 11, 12
Chemistry S
Unit: Chemical Formulas and
Equations

Chemistry Quiz

1. _________ moles of _________ would be equal to:

   ____________ molecules

   ____________ atoms

   ____________ moles of molecules

   ____________ moles of atoms

   ____________ grams

2. $2Na + Zn(NO_3)_2 \longrightarrow Zn + 2NaNO_3$

   According to the chemical reaction above, how many moles of zinc would be produced from _________ grams of sodium?

Unit Outline
Grades 10, 11, 12
Chemistry S
Unit: Measurement

See Fundamental Concepts Unit

Unit Outline
Grades 10, 11, 12
Chemistry S
Unit: Physical States
of Matter

I. The Gas Laws

- A. Kinetic theory
- B. Observed properties of gases
- C. Kinetic-theory description of a gas
- D. Attractive forces between gas molecules
- E. Dependence of gas volume on temperature and pressure
- F. Standard temperature and pressure
- G. Variation of gas volume with pressure: Boyle's Law
- H. Using Boyle's Law
- I. Variation of gas volume with temperature
- J. Kelvin temperature scale
- K. Charles' Law
- L. Use of Boyle's and Charles' Laws combined
- M. Pressure of a gas collected by displacement of mercury
- N. Pressure of a gas collected by water displacement
- O. Behavior of real gases
- P. General gas law
- Q. Graham's law of diffusion

II. Molecular Composition of Gases

- A. Law of combining volumes of gases
- B. Avogadro's Principle
- C. Molecules of active gaseous elements are diatomic
- D. Molecules of the noble gases are monatomic
- E. Molar volume of a gas
- F. Molecular weight of gases determined experimentally
- G. Chemical problems involving gases
- H. Gas volume-gas volume problems
- I. Mass-gas volume problems
- J. Gases not measured at STP
- K. Gases collected by water displacement
- L. The gas constant
- M. Real gases and the ideal gas

III. Liquids-Solids-Water

- A. Liquids
  1. Properties of liquids
  2. Kinetic-theory description of a liquid
  3. Dynamic equilibrium
  4. Equilibrium vapor pressure
  5. LeChatelier's Principle
  6. Boiling of liquids
  7. Liquefaction of gases
  8. Critical temperature and molecular attraction

B. Solids
   1. Properties of solids
   2. Kinetic-theory description of a solid
   3. Calculation of heat involved in phase changes
   4. Amorphous solids
   5. Nature of crystals
   6. Binding forces in crystals

C. Water
   1. Physical properties of water
   2. Structure and properties of water molecules
   3. Chemical behavior of water
   4. Efflorescence
   5. Deliquescence
   6. Deuterium oxide

Suggested Activities
Grades 10, 11, 12
Chemistry S
Unit: Physical States of
Matter

OBJECTIVE: To set up the apparatus for a simple distillation, and to gain insight as to when distillation will be effective and when it will not

TITLE: "Distillation"

SOURCE: Teacher developed

OBJECTIVE: To enumerate when fractional distillation is necessary, and to explain why a complete separation is not possible with distillation

TITLE: "Fractional Distillation"

SOURCE: Teacher developed

OBJECTIVE: To apply Dalton's Law to a specific situation in determining a numerical value for the general gas constant

TITLE: "The General Gas Constant"

SOURCE: Toon and Ellis. Laboratory Experiments for Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968.

OBJECTIVE: To determine an experimental molar volume for hydrogen

TITLE: "Molar Volume of a Gas"

SOURCE: Toon and Ellis. Laboratory Experiments for Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968.

OBJECTIVE: To apply Avogadro's Principle in the calculation of the molecular mass for natural gas

TITLE: "Molecular Mass of an Unknown Gas"

SOURCE: Toon and Ellis. Laboratory Experiments for Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968.

OBJECTIVE: To plot and interpret a time-temperature graph, and to interpret energy changes that occur during a phase change

TITLE: "Energy Changes During a Phase Change"

SOURCE: Toon and Ellis. Laboratory Experiments for Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968.

OBJECTIVE: To identify sources of error in an experiment, and to calculate the heat of fusion of ice

TITLE: "Heat of Fusion of Ice"

SOURCE: Teacher developed

Text Materials

Nebergall, William H. General Chemistry. Heath Publishing Co., 1976.

Toon and Ellis. Laboratory Experiments for Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968.

Film Loops -- High School Learning Center

The Surface of Water

Convection in Liquids

Cassette Tapes -- High School Learning Center

Heat Transfer in Chemical Reactions (tape #11)

Ideal Gas Law Calculation (tape #10)

Worksheets

Gas Law Problems

GMV, Molecular Weight, Weight-Volume, Volume-Volume, and Other Assorted Problems

More Gas

Phase Change Colorimetry

Exemplary Activity
Grades 10, 11, 12
Chemistry S
Unit: Physical States of
Matter

OBJECTIVE: To set up the apparatus for a simple distillation, and to gain insight as to when distillation will be effective and when it will not

MATERIALS AND EQUIPMENT: See Procedure

BACKGROUND: The process of distillation is an ancient art, known and practiced in the earliest civilizations and handed down by them to the alchemists. Yet it is, and doubtless always will be, a standard tecnhique of the modern laboratory and industrial chemical plant (oil refineries being an outstanding example). Its function is that of separating two volatile substances having different boiling points or of separating volatile substances from nonvolatile ones.

PROCEDURE:

1. Distill a mixture of 50. ml of tap water and a few crystals each of potassium chromate, sodium chloride, and sucrose.
    - Put the apparatus together according to your instructor's directions.
    - The condenser and flask should be securely clamped to avoid disaster (financial and otherwise).
    - All glassware used in this exercise should be very clean.
    - The portion that goes through the condenser and is collected is called the distillate. The portion that remains in the flask is called the residue.
    - Make sure the solids are completely dissolved before distilling.
    - Test the distillate by tasting (if you are sure of yourself and your condenser) and observing its appearance.
2. Distill a mixture of 40. ml of tap water and 10. ml of carbonated water (club soda).
    - Test by adding 5 ml of limewater to the distillate. Watch closely as you add it.
3. Distill a mixture of 40. ml of tap water and 10. ml of ammonium hydroxide solution.
    - Test the distillate by odor (carefully) and the addition of a drop of phenolphthalein solution.

Suggested discussion topics:

1. A comparison of the effectiveness of distillation for these three types of mixtures

2. An explanation of how the condenser works physically

3. The chemical equation for the limewater test

4. An explanation of why distillation works better for some mixtures than for others

5. An explanation of the importance of cleanliness in this exercise

6. A diagram of the apparatus

Evaluation Sample
Grades 10, 11, 12
Chemistry S
Unit: Physical States of
Matter

Chemistry Quiz

1. If the temperature of a rigid sealed container of hydrogen chloride gas at 760. torr were increased from -5 degrees celcius to 15 degrees celcius, what would the pressure inside the container be?

2. What is the volume of a container of oxygen gas if it contains 1.90 grams of gas at 20. degrees celcius and 900. torr?

3. A mixture of 56 grams of nitrogen gas, 8 grams of hydrogen gas, and 66 grams of carbon dioxide gas exerts a pressure of 2.68 atmospheres at 100. degrees celcius. What is the pressure due to the carbon dioxide in the mixture?

Unit Outline
Grades 10, 11, 12
Chemistry S
Unit: Solutions and Their Properties

I. The Solution Process

- A. Solutions and suspensions
- B. Types of solutions
- C. Solvents are selective
- D. Hydrogen bonds and properties of solvents
- E. Solvent equilibrium
- F. Influence of pressure on solubility
- G. Temperature and solubility
- H. Increasing the rate of dissolving
- I. Dissolving mechanisms
- J. Heat of solution
- K. Concentration of solutions -- calculation of molarity, molality, percent solute
- L. Freezing-point depression of solvents
- M. Boiling-point elevation of solvents
- N. Molecular weights of solutes

II. Ionization

- A. Conductivity of solutions
- B. Electrolytes as solutes
- C. Behavior of electrolytes explained
- D. Structure of electrovalent compounds
- E. Hydration of ions
- F. Some covalent compounds ionize
- G. Strength of electrolytes
- H. Ionization of water
- I. Substances that do not ionize
- J. Effects of electrolytes on the freezing and boiling points of solvents
- K. The degree of ionization

III. Acids, Bases, and Salts

- A. Acids
  - 1. Importance of acids
  - 2. Industrial acids
  - 3. Aqueous acids
  - 4. Modern definition of acids
  - 5. Properties of aqueous acids
  - 6. Naming of aqueous acids
  - 7. Acid anhydrides
- B. Bases
  - 1. The nature of bases
  - 2. Characteristics of hydroxides
  - 3. Basic anhydrides
  - 4. Hydroxides and periodic trends
  - 5. Relative strengths of acids and bases

- C. Salts
    - 1. Nature of salts
    - 2. Salt-producing reactions
    - 3. Naming salts

IV. Acid-Base Titration and pH

- A. Titration
    - 1. Chemical equivalents
    - 2. Calculation of normality
    - 3. Ion concentration in water
    - 4. Titration curves
- B. pH
    - 1. The pH of a solution
    - 2. pH calculations
    - 3. Acid-base titration
    - 4. Indicators in titration
- C. Weak acids and bases
    - 1. Calculation of dissociation constants
    - 2. Calculation of concentrations of species

Suggested Activities
Grades 10, 11, 12
Chemistry S
Unit: Solutions and Their Properties

OBJECTIVE: To relate the nature of solute and solvent to solubility, and to investigate the effect of temperature on solubility

TITLE: "Solutes, Solvents, and Solutions"

SOURCE: Toon and Ellis. Laboratory Experiments for the Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968.

OBJECTIVE: To use separation techniques learned previously, and to enumerate experimentally the relationship between the mass of reactants and the mass of product

TITLE: "Production of Lead (II) Chromate"

SOURCE: Teacher developed

OBJECTIVE: To determine properties of acids, and to identify the relationship between parent acid and base and the salt produced

TITLE: "Properties of Acids and Bases"

SOURCE: Toon and Ellis. Laboratory Experiments for the Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968.

OBJECTIVE: To become familiar with quantitative aspects of reactions involving solutions, and to verify that substances react in fixed mole ratios

TITLE: "Reactions of Solutions of Known Concentrations"

SOURCE: Toon and Ellis. Laboratory Experiments for the Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968.

OBJECTIVE: To determine the percentage of silver in an alloy, and to become familiar with the process of doing a volumetric analysis

TITLE: "Quantitative Volumetric Analysis"

SOURCE: Toon and Ellis. Laboratory Experiments for the Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968.

OBJECTIVE: To prepare a chemical indicator, and to determine the pH of common substances using the prepared indicator

TITLE: "Preparation and Use of a Chemical Indicator"

SOURCE: Toon and Ellis. Laboratory Experiments for the Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968.

OBJECTIVE: To prepare a buffer solution, and to observe its action and relationship to equilibrium systems

TITLE: "Weak Acids and Weak Bases"

SOURCE: Toon and Ellis. Laboratory Experiments for the Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968.

OBJECTIVE: To apply the concept of normality in the determination of the percentage of acetic acid in commercial vinegar

TITLE: "Acid-Base Titrations"

SOURCE: Toon and Ellis. Laboratory Experiments for the Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968.

Resources
Grades 10, 11, 12
Chemistry S
Unit: Solutions and Their
Properties

Text Materials

Nebergall, William H. General Chemistry. Heath Publishing Co., 1976.

Toon and Ellis. Laboratory Experiments for Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968.

Cassette Tapes -- High School Learning Center

Acid-Base Theory: States of Matter (tape #16)

Chemical Calculations Using Solution Concentrations (Titration) (tape #17)

Colligative Properties (tape #13)

Expressing Concentrations of Solutions (tape #12)

Ionic Equilibrium I: Logarithms, pH, and Strong Acids (tape #23)

Ionic Equilibrium II: Weak Acids (Bases) and Buffer Solutions (tape #24)

Ionic Equilibrium III: Hydrolysis of Salts (tape #25)

Ionic Equilibrium V: Polyprotic Acids and pH Control of Solubility (tape #27)

Worksheets

Gram-Equivalent Weights and Normality

Molarity

Molarity and Colligative Properties

Moles in Solutions

Normality and pH Problems

Normality and Volumetric Analysis

Percentage Concentration of Solutes

pH Problems

Solution Problems

OBJECTIVE: To use separation techniques learned previously, and to enumerate experimentally the relationship between the mass of reactants and the mass of product

MATERIALS AND EQUIPMENT: See Procedure

BACKGROUND: Your purpose in this exercise is to produce exactly .01 mole of lead (II) chromate. The reaction that you will employ will be a metathesis reaction between potassium chromate and lead (II) nitrate, and, like most reaction, will be carried out in solution. You should come to lab with all of the necessary calculations done so that you can begin to work immediately.

PROCEDURE:

1. Measure out the appropriate mass of each reactant and dissolve in 10-15 ml of distilled water prior to combination.
2. Combine the reactants and heat gently for about 5 minutes, stirring occasionally.
3. Separate the two products by filtration of the mixture.
4. Recover the product in the filtrate by evaporation.
5. Weigh the two products. Successive weighings should agree to within .05 gram.

Suggested discussion topics:

1. The balanced chemical equation for the reaction that took place in this exercise
2. All neatly written, labeled calculations that were done prior to the lab period
3. Calculation of each of the following for each product:
    a. theoretical yield
    b. actual yield
    c. error
    d. percentage error
4. An explanation of the problems encountered and factors leading to experimental error

Evaluation Sample
Grades 10, 11, 12
Chemistry S
Unit: Solutions and Their
Properties

Chemistry Quiz

1. When __________ ml of a ____________ M KCl solution are diluted with water to yield 500. ml, what is the new molar concentration?

2. The solubility of _________ is _____________. Explain exactly what these numbers mean.

3. If ____________ grams of NaBr are dissolved in ____________ grams of water, what is the percent solute concentration?

4. If a $Cu(NO_3)_2$ solution is .10 M, how much solution contains _____________ grams of solute?

5. According to the following graph, what is the solubility of ____________ at ____________ degrees C?

Unit Outline
Grades 10, 11, 12
Chemistry S
Unit: Chemical Reactions

I. Reaction Energy and Reaction Kinetics

- A. Introduction
- B. Energy of reaction
  - 1. Calculation of heat of reaction
  - 2. Calculation of heat of formation
  - 3. Stability and heat of formation
  - 4. The heat of combustion
  - 5. Calculation of entropy changes
  - 6. Free energy as the driving force in a reaction
  - 7. Calculation of free energy changes
- C. Reaction mechanisms
  - 1. Activation energy
- D. Reaction rates
  - 1. Rate influencing factors
  - 2. Calculation of reaction rates from data

II. Chemical Equilibrium

- A. Reversible reactions
- B. Equilibrium, a dynamic state
- C. Calculation of the equilibrium constant
- D. Factors that disturb equilibrium
- E. Reactions that run to completion
- F. Calculation of equilibrium concentrations of species
- G. Equilibrium constant expression
- H. Special equilibrium constants (K_w, K_a, K_b, K_{sp})

III. Oxidation-Reduction Reactions

- A. Oxidation and reduction processes
- B. Oxidation and reduction occur simultaneously
- C. Oxidizing and reducing agents
- D. Electrochemical reactions
- E. Electrolysis of water
- F. Electroplating
- G. Lead storage battery
- H. Balancing redox reactions using half-reactions
- I. Fuel cells

Suggested Activities
Grades 10, 11, 12
Chemistry S
Unit: Chemical Reactions

OBJECTIVE: To determine the effect of concentration and temperature on the rate of a reaction

TITLE: "Factors Affecting Rates of Chemical Reactions"

SOURCE: Toon and Ellis. Laboratory Experiments for the Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968.

OBJECTIVE: To observe and explain the effect of concentration and temperature on a system at equilibrium

TITLE: "Chemical Equilibrium and Application of Le Chatelier's Principle"

SOURCE: Toon and Ellis. Laboratory Experiments for the Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968.

OBJECTIVE: To investigate energy changes that occur during a chemical reaction, and to determine the heats of reaction for three chemical reactions

TITLE: "Additivity of Heats of Reaction"

SOURCE: Toon and Ellis. Laboratory Experiments for the Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968.

OBJECTIVE: To investigate the behavior of some common oxidizing and reducing agents, to prepare a list of oxidizing and reducing agents in order of strength, and to prepare blueprint paper and a blueprint

TITLE: "Oxidation-Reduction Reactions"

SOURCE: Toon and Ellis. Laboratory Experiments for the Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968.

OBJECTIVE: To illustrate the principle of electrochemical metallic corrosion, and to show where the cathode and anode sites are by means of chemical indicators

TITLE: "The Corrosion of Iron (Salt-Drop Experiment)"

SOURCE: Teacher developed

Resources
Grades 10, 11, 12
Chemistry S
Unit: Chemical Reactions

Text Materials

Nebergall, William H. General Chemistry. Heath Publishing Co., 1976.

Toon and Ellis. Laboratory Experiments for Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968.

Films

Equilibrium

Film Loops -- High School Learning Center

Electrolysis of Water

Equilibrium: Solutions and Precipitates

Galvanic Cells: Electrolytes and Electrodes

Galvanic Cells: Half Cell Reactions

H_2-O_2 Fuel Cell

Le Chatelier's Principle

Oxidation and Reduction -- Electrolytic Cells

Oxidation and Reduction -- Halogens

Reaction Rates

Cassette Tapes -- High School Learning Center

Balancing Redox Equations by the Bridge Method (tape #9)

Chemical Kinetics (tape #29)

Electrochemistry I: Spontaneous Reactions and Galvanic Cells (tape #31)

Electrochemistry II: Concentration Effects and the Nernst Equation (tape #32)

Electrolysis and Faraday's Laws (tape #15)

Cassette Tapes (Cont.)

General Equilibrium I: Equilibrium Expressions and Le Chatelier's Principle (tape #21)

General Equilibrium II: Equilibrium Calculations (tape #22)

Heat Transfer in Chemical Reactions (Thermochemistry) (tape #11)

Redox Reactions in Terms of Half Cells (tape #14)

Thermodynamics: Enthalpy, Entropy, and Free Energy (tape #20)

Worksheets

Balancing Redox Equations

Electrochemistry

Enthalpies of Reaction

Reaction Kinetics

Selected Equilibrium Problems

Thermodynamics

Exemplary Activity
Grades 10, 11, 12
Chemistry S
Unit: Chemical Reactions

OBJECTIVE: To illustrate the principle of electrochemical metallic corrosion, and to show where the cathode and anode sites are by means of chemical indicators

MATERIALS AND EQUIPMENT: See Procedure

BACKGROUND: Metals corrode in aqueous solutions by electrochemical means. This exercise is designed to illustrate this principle by use of color changes of suitable indicators.

On the surface of a piece of metal undergoing corrosion, there are both anodic and cathodic sites. An anodic is defined as one where electrons are lost and oxidation occurs. Conversely, a cathodic site is one where electrons are gained and reduction occurs. A simplified mechanism for the corrosion of iron in aqueous environments is as follows:

1. at the anodic site: $FE_{(s)} \longrightarrow Fe^{++}_{(aq)} + 2e-$
2. at the cathodic site: a) $2H^{+}_{(aq)} + 2e- \longrightarrow H_2\ (g)$

   (liberation of hydrogen gas from acidic solutions)

   b) $O_{2(aq)} + 2H_2O + 4e- \longrightarrow 4OH-_{(aq)}$

   (reduction of dissolved oxygen)
3. $Fe^{++}_{(aq)} + 2OH-_{(aq)} \longrightarrow Fe(OH)_{2(s)}$

   $Fe(OH)_{2(s)} \xrightarrow[\text{oxidation}]{} Fe_2O_3 \cdot H_2O_{(s)}$

PROCEDURE:

1. Each bay of lab teams combines to make up an agar-agar gel. When it is made, distribute it among the lab teams in the bay.
   a. Add 7.5 grams of NaCl to 250 ml of distilled water in a 400 ml beaker.
   b. Add 5.0 grams of agar-agar.
   c. Boil the mixture until the ingredients are completely dispersed.
   d. Add 5 ml of 5% potassium ferricyanide solution $[K_3FE(CN)_6]$.
   e. Add 1 ml of 1% phth solution.
   f. Stir all the ingredients until well mixed.

2. Prepare a piece of steel by:
   a. rubbing it (in one direction) with abrasive paper
   b. washing it off with acetone.
3. Place a large drop of gel on the cleaned steel surface and observe the sequence of events that occurs. A reaction that might help you in your interpretation of the phenomena is as follows:

$$3Fe^{++}_{(aq)} + 2Fe(CN)_6^{-3} \longrightarrow \underset{\text{blue precipitate}}{Fe\left[Fe(CN)_6\right]_{2(s)}}$$

4. Sketch a top view and a cross-sectional view of the drop after the reactions have taken place.

Suggested discussion topics:

1. Explain why it is said that the corrosion of metal is an electrochemical phenomenon. (Is there really a flow of electricity?)
2. Discuss how the anode and cathode complement each other and what basically happens at each in metallic corrosion.
3. Explain why the anodic reaction does not stop from accumulated corrosion products piling up.
4. What is the role of: (a) water and (b) the sodium chloride?
5. Explain how the indicators in this exercise signalled the cathodic and anodic reactions.

References:

Toon and Ellis. 12-1, "Additivity of Heats of Reaction," Laboratory Experiments for Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968, pp. 113-115.

Ibid. 13-1, "Factors Affecting Rates of Chemical Reactions," pp. 117-119.

Evaluation Sample
Grades 10, 11, 12
Chemistry S
Unit: Chemical Reactions

Chemistry Quiz

1. REACTION: (Reaction provided by instructor.)

   $H_r^\circ =$

   Answer the following about the above reaction:

   a. Is this reaction exothermic or endothermic?

   b. Do the surroundings gain heat or lose heat?

   c. Does the system gain heat or lose heat?

   d. Which have greater enthalpy -- products or reactants?

   e. Which have stronger bonds -- products or reactants?

   f. Write the reaction including the energy (use a number, not "q").

2. REACTION: (Reaction provided by instructor.)

   $H_r^\circ =$

   a. Calculate the heat of formation of ________________________.

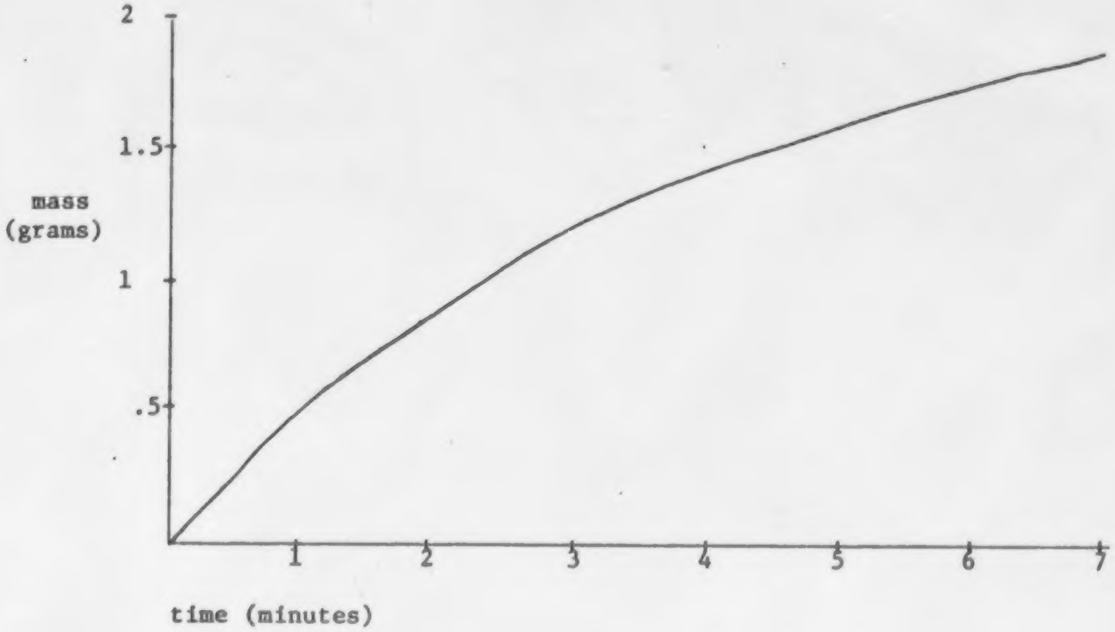
   b. Calculate the ΔS° for this reaction.

   c. Calculate the ΔG° for this reaction.

   d. Calculate the temperature at which this reaction would be in equilibrium.

   e. Is this reaction spontaneous as written at standard conditions?

Chemistry Quiz



1. According to the graph above, what was the rate of the reaction at ______ min.? Answer in moles of precipitate produced per minute. The molecular mass of the precipitate is ___________ amu.

   -Calculate the average rate of reaction from ______ to ________ minutes, again answering in moles of precipitate produced per minute.

2. REACTION: (Reaction provided by instructor.)

   Draw a graph of reaction coordinate vs potential energy, labeling reactants, products, heat of reaction, and activation energy.

   -Is this reaction endothermic or exothermic?

3. Suggest a way of monitoring the rate of this reaction.

Unit Outline
Grades 10, 11, 12
Chemistry S
Unit: Descriptive Chemistry

I. Elements Particularly Emphasized

- A. Hydrogen
  1. Abundance in universe
  2. Atomic energy production by fusion in stars and hydrogen bomb
  3. Importance
  4. Properties
  5. Preparation
- B. Oxygen
  1. Abundance in continental crust and biosphere
  2. Importance
  3. Properties
  4. Preparation
  5. Allotropic forms
- C. Carbon
  1. Abundance and importance
  2. Characteristics of carbon atoms
  3. Allotropic forms of carbon
  4. Diamond
  5. Graphite
  6. Uses of graphite
  7. Destructive distillation
  8. Coke
  9. Charcoal
  10. Boneblack
  11. Activated charcoal
  12. Other forms of amorphous carbon
- D. Sulfur
  1. Occurrence of sulfur
  2. The production of sulfur
  3. Physical properties of sulfur
  4. Allotropic forms of sulfur
  5. Chemical properties of sulfur
  6. Uses of sulfur
- E. Nitrogen
  1. Occurrence
  2. Properties
  3. Compounds of
  4. Uses of
  5. Production of

II. Descriptive Chemistry from Chemical Periodicals -- Student Readings From General Topics on Elements, Atomic Structure, Biography

III. Career Education in Science Areas

IV. Nuclear Chemistry

A. Nuclear reactions
B. Radioactivity
C. Cloud chamber and nuclear scalar
D. Nuclear reactors
E. Nuclear waste
F. Nuclear safety

OBJECTIVE: To relate a chemical equation with its reaction, and to observe some of the physical and chemical properties of hydrogen

TITLE: "A Study of Hydrogen"

SOURCE: Teacher developed

OBJECTIVE: To illustrate the role of a catalyst in a chemical reaction, to learn about oxygen's role in combustion, to observe some of the physical properties of oxygen, and to become familiar with the relationships among nonmetals, acidic anhydrides, and acids

TITLE: "A Study of Oxygen"

SOURCE: Teacher developed

OBJECTIVE: To observe some of the common forms of carbon, and to see how carbon can act as an adsorbing and reducing agent

TITLE: "Properties of Carbon"

SOURCE: Teacher developed

OBJECTIVE: To prepare the allotropic forms of sulfur, to investigate some of the physical and chemical properties of sulfur, and to observe some of the properties of SO_2, H_2SO_4, and H_2S

TITLE: "Sulfur and Its Compounds"

SOURCE: Toon and Ellis. Laboratory Experiments for the Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968.

OBJECTIVE: To investigate some of the properties of nitrogen compounds, to observe how NH_3 and HNO_3 are prepared in the lot, and to investigate how nitric acid acts as an oxidizing agent

TITLE: "Nitrogen Compounds"

SOURCE: Toon and Ellis. Laboratory Experiments for the Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968.

OBJECTIVE: To relate shapes and bond angles of chemical species to number of bonded and unbonded election pairs in valence level of the central atom; to relate polarity of molecules to shapes and symmetry of chemical species

TITLE: "Shapes of Molecules and Polyatomic Ions"

SOURCE: Toon and Ellis. *Laboratory Experiments for the Foundation of Chemistry*. Holt, Rinehart, and Winston, Inc., 1968.

OBJECTIVE: To examine properties associated with ionic and molecular compounds, and to relate properties of compounds to type of bond between particles

TITLE: "Chemical Bonding"

SOURCE: Toon and Ellis. *Laboratory Experiments for the Foundation of Chemistry*. Holt, Rinehart, and Winston, Inc., 1968.

OBJECTIVE: To determine the percentage of H_2O in a hydrate, and to establish the formula of a hydrate from data

TITLE: "Decomposition, Formation, and Reaction of a Hydrate"

SOURCE: Toon and Ellis. *Laboratory Experiments for the Foundation of Chemistry*. Holt, Rinehart, and Winston, Inc., 1968.

Resources
Grades 10, 11, 12
Chemistry S
Unit: Descriptive Chemistry

Text Materials

Nebergall, William H. General Chemistry. Heath Publishing Co., 1976.

Toon and Ellis. Laboratory Experiments for Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968.

Films

Chemical Bonding

Shapes and Polarities of Molecules

Cassette Tapes -- High School Learning Center

Chemical Bonding and Molecular Properties (tape #19)

Nomenclature (tape #8)

Oxidation Number, Formal Charge (tape #7)

Worksheets

Bonding

Lewis Structures

Naming Compounds (2)

Oxidation States of Elements

Writing Formulas From Compounds' Names

Exemplary Activity
Grades 10, 11, 12
Chemistry S
Unit: Descriptive Chemistry

Reference:

Toon and Ellis. 10-1, "Chemical Bonding," Laboratory Experiments for Foundations of Chemistry. Holt, Rinehart, and Winston, Inc., 1968, pp. 94-97.

Evaluation Sample
Grades 10, 11, 12
Chemistry S
Unit: Descriptive Chemistry

Chemistry Quiz

Multiple guess: Put the response of your choice in the blank preceding each item. Use capital letters.

____ 1. The black in pencils is actually (A) bone black (B) carbon black (C) graphite (D) coke (E) charcoal.

____ 2. The property of activated charcoal that makes it activated is its (A) large surface area (B) large amount of K.E. (C) consistency (D) high melting point (E) solubility in water.

____ 3. Which of the following is used as an abrasive? (A) lampblack (B) charcoal (C) calcium carbide (D) coke (E) silicon carbide

____ 4. Which of the following is used as a refrigerant? (A) baking soda (B) baking powder (C) solid carbon dioxide (D) lignite (E) hemoglobin

____ 5. Carborundum is a common name for (A) Ca_2C (B) SiC (C) CH_4 (D) C (E) CO_2.

____ 6. The decolorizing of sugar by activated charcoal is an example of (A) adsorption (B) corrosion (C) allotropism (D) cohesion (E) hybridization.

____ 7. Carbon monoxide inhalation can be fatal since carbon monoxide (A) is odorless (B) is colorless (C) oxidizes to form carbon dioxide (D) combines readily with hemoglobin (E) is a poor reducing agent.

____ 8. Graphite is used in nuclear reactors because it (A) slows down neutrons (B) accelerates neutrons (C) slows down electrons (D) is noncorrosive (E) conducts heat readily.

9. Write the names of four different substances whose formulas are $CaCO_3$.

a.
b.
c.
d.

10. Explain the difference in structure between diamonds and graphite. Include your best sketches in your explanation.

Evaluation Sample (Cont.)
Grades 10, 11, 12
Chemistry S
Unit: Descriptive Chemistry

11. List the four stages of coal formation in order of increasing carbon content.

    a.
    b.
    c.
    d.

12. How many points would a ____________ gram diamond be?

13. How is ______________ produced?

14. Name a common use for _________________.

15. Write the chemical equations for any four of the following reactions. Include all relevant information.

    a. The reaction between carbon dioxide and water

    b. The reduction of copper (II) oxide by charcoal

    c. The production of graphitic carbon from sucrose

    d. The reaction between carbon dioxide and limewater

    e. The reduction of iron (III) oxide by carbon monoxide

    f. The reaction between a metal and carbon to form a carbide

16. From the reaction that you performed in lab, how many grams of copper would be produced from 72.0 grams of carbon combined with an excess of copper (II) oxide?

Evaluation Sample (Cont.)
Grades 10, 11, 12
Chemistry S
Unit: Descriptive Chemistry

Chemistry Quiz

1. Sketch the e- dot formula (Lewis structure) for ___________________. Use the electronegativities of the elements and show in your sketch the predominant type of bonding.

2. What is the name of the shape of a molecule of ____________________?

3. What type of hybridization does the central atom have in a molecule of ______________________?

4. List 3 physical properties of a crystalline substance whose particles are held together in the crystal by _________________.

   a.
   b.
   c.

5. What is the name of the shape of a molecule of ____________________?

Unit Outline
Grades 11, 12
Advanced Chemistry
Unit: Biochemistry

Biochemical Molecules and Functions

I. Stereoisomerism

- A. Optical activity
- B. Biological activity

II. Biochemical Molecules

- A. Amino acids and proteins
  - 1. Structure and nomenclature
  - 2. Peptide bonds
- B. Carbohydrates
  - 1. Mono-, di-, tri-, polysaccharides
- C. Lipids and membranes
  - 1. Phospholipids
  - 2. Triglycerides
- D. Enzymes, vitamins, and hormones

III. Body Fluids

- A. Digestive juices
- B. Blood
- C. Urine

IV. Evolution of Life Chemicals

- A. Early earth
- B. Importance of water
- C. Alternate evolutionary possibilities

V. Metabolism

- A. Adenosine triphosphate (ATP)
- B. Electron transport system
- C. Pathways of glucose metabolism

VI. Chemistry of Heredity

Suggested Activities
Grades 11, 12
Advanced Chemistry
Unit: Biochemistry

OBJECTIVE: To investigate the physical and chemical properties of amino acids; to hydrolyze proteins and examine the resultant products

TITLE: "Amino Acids and Proteins"

SOURCE: Ouellette, Robert. Introductory Experimental Chemistry, 2nd Edition. Harper and Row Publishers, pp. 173-182.

OBJECTIVE: To separate the components of a mixture of amino acids

TITLE: "Chromatography"

SOURCE: Ouellette, Robert. Introductory Experimental Chemistry, 2nd Edition. Harper and Row Publishers, pp. 199-204.

OBJECTIVE: To compare the chemical reactivity of different classes of saccharides

TITLE: "Carbohydrates"

SOURCE: Ouellette, Robert. Introductory Experimental Chemistry, 2nd Edition. Harper and Row Publishers, pp. 183-191.

OBJECTIVE: To compare the sweetness of mono- and disaccharides

TITLE: "How Sweet It Is"

SOURCE: Martin, D., and Sampugna, J. "Molecules in Living Systems," Interdisciplinary Approaches to Chemistry. Harper and Row, 1974, p. 26.

OBJECTIVE: To compare the chemical properties of fats and oils; to prepare soap and compare its properties with detergents

TITLE: "Fats, Oils, Soaps, and Detergents"

SOURCE: Ouellette, Robert. Introductory Experimental Chemistry, 2nd Edition. Harper and Row Publishers, pp. 193-198.

OBJECTIVE: To test urine for sugar, protein, ketones, blood, and pH

TITLE: "Urine, What's in Yours?"

SOURCE: Scott, Lawrence. Chemical Investigations for Changing Times. Burgess Publishing Co., p. 35.

Text Materials

Ouellette, Robert J. Introductory Chemistry. Harper and Row, 1975, pp. 565-650.

Supplementary Materials

Brown, William. Introduction to Organic and Biochemistry. Willard Grant Press, 1977.

Lehninger, Albert. Short Course in Biochemistry, "Molecular Logic of Living Organisms." Worth Publishing, 1973, pp. 1-9.

Martin, David. Interdisciplinary Approaches to Chemistry, "Molecules in Living Systems." Harper and Row, 1973.

Suttie, John. Introduction to Biochemistry. Holt, Rinehart and Winston, 1977, Chapters 7, 8, and 15.

Films

Fluids in Weightlessness -- NASA

Ladder of Creation -- Columbus Public Library

Life Beyond Mars and the Mind of Man -- NASA

Power of Ten -- Grandview Heights Public Library

Universe -- NASA

Who's Out There -- NASA

Filmstrips -- High School Learning Center

ATP

Biochemistry for Biology

Tapes -- High School Learning Center

Molecules in Space

Transparencies -- High School Learning Center

Enzymes

Exemplary Activity
Grades 11, 12
Advanced Chemistry
Unit: Biochemistry

Reference:

Ouellette, Robert. "Amino Acids and Proteins," Introductory Experimental Chemistry, 2nd Edition. Harper and Row Publishers, pp. 173-182.

Evaluation Sample
Grades 11, 12
Advanced Chemistry
Unit: Biochemistry

1. What properties of liquid water make it an important requirement for the evolution of life?

2. Discuss the makeup of the primitive atmosphere and changes that occurred as the percentage of oxygen increased.

3. To have life originate on other planets, certain conditions must exist. List and discuss three of these.

4. What evidence is there that man and E. coli evolved from a common ancestor?

5. List and discuss three ways enzymes surpass inorganic catalysts.

6. There are eleven essential coenzymes. What do they do and where do most come from?

7. Explain the lock and key theory.

8. Why do most enzymes have catalytic activity when heated above 50-60°C?

9. Many standard clinical diagnostic tests involve checking various enzyme levels in the blood. Why are these tests effective and what can they show?

Unit Outline
Grades 11, 12
Advanced Chemistry
Unit: Organic

I. Hydrocarbons

- A. Alkanes -- paraffin series
    - 1. IUPAC naming
    - 2. Hybridization of orbitals
- B. Alkenes -- olefin series
- C. Alkynes -- acetylene series
- D. Cyclic compounds
- E. Isomerization
    - 1. Structural
    - 2. Positional
    - 3. Geometrical
    - 4. Optical
- F. Aromatic -- benzene

II. Functional Groups

- A. Hydroxyl
    - 1. Alcohols and phenols
    - 2. Ethers
- B. Carbonyl
    - 1. Aldehydes
    - 2. Ketones
- C. Carboxyl
    - 1. Acids and anhydrides
    - 2. Esters
    - 3. Acyl halides and amides
- D. Other elements
    - 1. Nitrogen
        - a. Amines and amides
        - b. Heterocyclic compounds
        - c. Alkaloids
    - 2. Sulfur
        - a. Thio -- alcohols and ethers

Suggested Activities
Grades 11, 12
Advanced Chemistry
Unit: Organic

OBJECTIVE: To develop the facility for visualizing three-dimensional molecules and geometric isomers; to construct models of optical isomers

TITLE: "Molecular Models I and II"

SOURCE: Ouellette, Robert. *Introductory Experimental Chemistry*, 2nd Edition. Harper and Row Publishers, pp. 113-136.

OBJECTIVE: To make and study the properties of polymers

TITLE: "Polymerization -- The Nylon Rope Trick"

SOURCE: Scott, Lawrence. *Chemical Investigations for Changing Times*. Burgess Publishing Co., p. 35.

OBJECTIVE: To compare the chemical and physical properties of aliphatic and aromatic hydrocarbons

TITLE: "Hydrocarbons"

SOURCE: Ouellette, Robert. *Introductory Experimental Chemistry*, 2nd Edition. Harper and Row Publishers, pp. 113-136.

OBJECTIVE: To examine the properties of alcohols and to determine how these properties vary with change in structure

TITLE: "Alcohols"

SOURCE: Ouellette, Robert. *Introductory Experimental Chemistry*, 2nd Edition. Harper and Row Publishers, pp. 147-154.

OBJECTIVE: To compare and contrast carbonyl compounds

TITLE: "Aldehydes and Ketones"

SOURCE: Ouellette, Robert. *Introductory Experimental Chemistry*, 2nd Edition. Harper and Row Publishers, pp. 155-164.

OBJECTIVE: To examine the chemical reactions of acids, acid chlorides and esters

TITLE: "Carboxylic Acids and Their Derivatives"

SOURCE: Ouellette, Robert. Introductory Experimental Chemistry, 2nd Edition. Harper and Row Publishers, pp. 113-136.

Resources
Grades 11, 12
Advanced Chemistry
Unit: Organic

Text Materials

Brown, William H. Introduction to Organic and Biochemistry, 2nd Edition. Willard Grant Press, 1976.

Ouellette, Robert J. Introductory Chemistry. Harper and Row, 1975, pp. 349-475.

Ouellette, Robert J. Introductory Experimental Chemistry, 2nd Edition. Harper and Row, 1975, pp. 113-165.

Films

Shapes and Polarities of Molecules. Modern Learning Aids

Filmstrips -- High School Learning Center

Functional Groups

Exemplary Activity
Grades 11, 12
Advanced Chemistry
Unit: Organic

Reference:

Ouellette, Robert. "Hydrocarbons," Introductory Experimental Chemistry, 2nd Edition. Harper and Row Publishers, pp. 113-136.

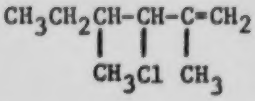
Evaluation Sample
Grades 11, 12
Advanced Chemistry
Unit: Organic

Alkane-Alkene

1. Write structural formula for:

    a. 2,5,6 trimethyl-3 ethyloctane

    b. 1,3 dichlora 4-fluoro-1, pentene

2. Give name for 

$CH_3CH_2\underset{CH_3}{CH}-\underset{Cl}{CH}-\underset{CH_3}{C}=CH_2$

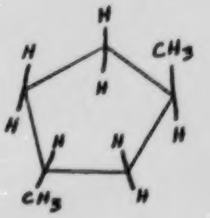
3. Correct the following names.

    a. 2-ethyl-1-propene ______________________________

    b. 3,3 dimethyl-4-pentene __________________________

    c. 2,2,3-trimethyl 2,2,1,trimethylethane ___________________________

4. Write structure for cis-2-methyl-3-hexene.

5. Name:  __________________________________

6. Does 2-methyl-2-hexene show cis, trans isomers? Explain.

7. Reactions

    a. Write and balance the reaction for the burning of heptane.

Give the structure of products.

b. $CH_3CH_3 \xrightarrow[\text{light}]{Br_2}$ ______________________

c. $CH_3CHCH_2 \xrightarrow{Cl_2}$ ______________________

d. $CH_3{-}CH_2{-}CH_2{-}CH{=}CH_2 \xrightarrow{HBr}$ ________________

8. Draw structure of 1-chloro-3-ethyl-4,5-difluoro-5-methyl-1-cyclohexene.

Unit Outline
Grades 11, 12
Physiology
Unit: The Whole Body

I. Basic Concepts

- A. Related branches
  1. Biochemistry
  2. Biophysics
  3. Morphology
  4. Anatomy
  5. Cytology
  6. Histology
  7. Pathology
  8. Psychology
  9. Genetics
- B. Historical picture
  1. Hippocrates
  2. Galen
  3. Harvey
  4. Bernard
- C. Scientific investigation
  1. Scientific method
  2. Fact, hypothesis, theory
- D. Body structure
  1. Cell, tissue, organ, system
  2. Types of symmetry
  3. Main body regions
  4. Body regions
  5. Body positions

II. Energy and Matter

- A. Energy -- definition
  1. Two kinds based on activity
  2. Five forms in biology
  3. Law of conservation
- B. Matter -- definition
  1. Three states
  2. Relation of matter to energy
  3. Law of conservation
- C. Structure of atom
  1. Three units
  2. Isotopes
  3. Ions and molecules
  4. Chemical compounds
- D. Suspensions
  1. Solutions, suspensions, colloids
  2. Emulsions
- E. Motion of molecules -- diffusion and osmosis
- F. Hydrogen ion concentration -- pH scale

III. The Cell

- A. Cell theory
  - 1. Contributions of Hooke, Dujardin, Brown, Schleiden, Schwann, Von Mohl, and Virchow
  - 2. Three parts of cell theory
- B. Cell structure
  - 1. Plasma membrane
  - 2. Cytoplasm
    - a. Endoplasmic reticulum
    - b. Ribosomes
    - c. Motochondria
    - d. Lysosomes
    - e. Golgi apparatus
    - f. Centrosome
    - g. Vacuoles
  - 3. Nucleus
    - a. Nuclear membrane
    - b. Nucleoplasm
    - c. Nucleolus
    - d. Chromatin
- C. Cell function
  - 1. Protoplasmic composition
  - 2. Metabolism -- definition
    - a. Anabolism and catabolism
    - b. Pinocytosis
    - c. Equation for respiration
    - d. Protein synthesis
  - 3. Irritability
  - 4. Growth
  - 5. Reproduction -- mitosis

IV. Cell Specialization

- A. Types of tissues
  - 1. Epithelium
    - a. Squamous
    - b. Endothelial
    - c. Stratified
    - d. Cuboidal
    - e. Columnar
    - f. Ciliated
  - 2. Muscle
    - a. Striated
    - b. Smooth
    - c. Cardiac

3. Connective
    a. Loose
    b. Adipose
    c. Liquid
    d. Fibrous
    e. Cartilage
    f. Bone
4. Nervous -- neuron

Suggested Activities
Grades 11, 12
Physiology
Unit: The Whole Body

OBJECTIVE: To review structure and functions

TITLE: "Use of the Microscope"

SOURCE: Morrison, et al. Experiments in Physiology. Holt, Rinehart, and Winston, 1972.

OBJECTIVE: To discover difference between physical and chemical changes; to study formation of chemical compounds

TITLE: "Physical and Chemical Changes in Matter"

SOURCE: Morrison, et al. Experiments in Physiology. Holt, Rinehart, and Winston, 1972.

OBJECTIVE: To observe and recognize cell structures and types of tissues

TITLE: "Microscopic Anatomy: Cells and Tissues"

SOURCE: Benson and Gunstream. Anatomy and Physiology Laboratory Textbook. W.C. Brown and Co., 1970.

OBJECTIVE: To observe and recognize stages of mitosis

TITLE: "Mitotic Cell Division"

SOURCE: Benson and Gunstream. Anatomy and Physiology Laboratory Textbook. W.C. Brown and Co., 1970.

OBJECTIVE: To illustrate differences in types of diffusion and osmosis

TITLE: "Molecular Activity and Cells"

SOURCE: Benson and Gunstream. Anatomy and Physiology Laboratory Textbook. W.C. Brown and Co., 1970.

Resources
Grades 11, 12
Physiology
Unit: The Whole Body

Text Materials

Benson, Harold J., and Gunstream, Stanley E. Anatomy and Physiology Laboratory Textbook. W.C. Brown and Co., 1970.

Chaffee and Greisheimer. Basic Physiology and Anatomy. J.B. Lippincott Co., 1969, pp. 1-56.

Morrison, et al. Experiments in Physiology. Holt, Rinehart, and Winston, 1972.

Morrison, et al. Human Physiology. Holt, Rinehart, and Winston, 1972, pp. 1-54.

Films -- Columbus Public Library

Atomic Energy

Cell Reproduction

Evidence for Atoms and Molecules

Filmstrips -- High School Learning Center

The Atom

Carbon -- Key Atom of Life

Cell Chemistry -- Carbohydrates

DNA and Protein Synthesis

DNA -- Structure and Replication

Proteins -- Molecules of Life

Transparencies

Active Transport -- teacher developed

Anatomy and Physiology (set of 14) -- High School Learning Center

Body Planes -- teacher developed

Body Regions -- teacher developed

Transparencies (Cont.)

The Cell -- teacher developed

DNA Molecule -- High School Learning Center

Mitosis: Animal Cells -- High School Learning Center

Protein Synthesis -- teacher developed

Slides With Cassette -- High School Learning Center

Anatomy and Physiology

Exemplary Activity
Grades 11, 12
Physiology
Unit: The Whole Body

Reference:

Benson, Harold J., and Gunstream, Stanley E. "Microscopic Anatomy: Cells and Tissues," Anatomy and Physiology Laboratory Textbook. W.C. Brown and Co., 1970, pp. 34-40.

Evaluation Sample
Grades 11, 12
Physiology
Unit: The Whole Body

Chapters 1-4
Multiple Choice.

____ 1. Physiology is a study of (A) the diseases of the body (B) the functions of the body (C) the tissues of the body (D) the structures of the body.

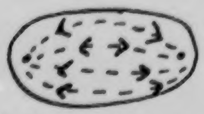
____ 2. The thoracic region of the human body is the (A) chest (B) neck (C) abdomen (D) head (E) appendages.

____ 3. Ligaments are white fibrous tissues that (A) separate the vertebrae of the spine (B) connect muscle to bone (C) join bones together (D) join muscles together.

____ 4. Cardiac muscle (A) lacks striations (B) is under voluntary control (C) contains many nuclei in each cell (D) is similar to smooth muscle (E) is striated and branched.

____ 5. Adipose tissue is (A) a storage tissue (B) a form of epithelial tissue (C) found less frequently in women than in men (D) composed of carbohydrates.

____ 6. The stage of mitosis represented by the drawing on the right is (A) telophase (B) anaphase (C) metaphase (D) prophase (E) interphase.



____ 7 The energy released by the oxidation of glucose is stored in special molecules called (A) amino acids (B) ADP (C) ATP (D) DNA (E) RNA.

____ 8. The part of a cell in which energy is released is the (A) nucleolus (B) mitochondria (C) endoplasmic reticulum (D) lysosome (E) vacuole.

____ 9. The mitotic division of a body cell (A) normally produces three new cells (B) requires the same length of time in all tissues (C) originates in a specific type of molecule in the nucleus (D) occurs in certain types of tissue only.

____10. The cell theory (A) was originally proposed by William Harvey (B) is a discovery of the 20th century (C) refers to the process of metabolism (D) has been discarded by modern scientists (E) states that the cell is the basic unit of life.

____11. Energy of motion is said to be (A) kinetic (B) dynamic (C) potential (D) mechanical.

____12. Which of the following statements about hydrogen ion concentration, pH, is NOT correct? (A) a reading below 7 indicates a greater number of H^+ than OH^- (B) the higher the reading the stronger the acid (C) is a measure of the alkalinity of a substance (D) has a neutral point of 7

____13. If the outer orbital of element X has two electrons and the outer orbital of element Y has six electrons, the molecular formula of a compound formed by the union of the two would be (A) X_2Y_2 (B) XY_3 (C) XY (D) X_6Y_2 (E) X_2Y_6.

____14. The end of a limb that lies nearest the main part of the body is called the (A) proximal (B) dorsal (C) distal (D) lateral.

____15. A statement of a tentative solution to a problem is a (A) hypothesis (B) theory (C) fact (D) law.

____16. If one were to cut the human body from head to foot through both ears, the cut would have been made through which plane? (A) ventral (B) frontal (C) transverse (D) midsagittal

____17. Serous fluid is produced by (A) muscle cells (B) cartilage (C) fat cells (D) epithelial cells (E) bone cells.

____18. Division of labor in the body involves (A) competition between cells for the needs of life (B) differentiation of cells into tissues (C) an increase in the number of cells (D) the growth of cells (E) the presence of a single group of similar cells.

____19. Smooth muscle tissue (A) contains many nuclei in each cell (B) is found in the walls of the arteries and veins (C) is attached to the skeleton (D) forms the walls of the heart.

____20. A group of different types of cells working together to perform one particular function is (A) a tissue (B) an organ (C) a system (D) an organism.

____21. Protein molecules are composed of long chains of (A) carbohydrates (B) amino acids (C) ribonucleic acids (D) fatty acids.

____22. The release of energy in a cell is (A) under the control of enzymes (B) the result of its becoming warm (C) controlled by the nervous system (D) the result of a cell using CO_2 (E) the result of the transformation of ADP to ATP.

____23. The plasma membrane (A) is a single-layered structure (B) cannot be seen with an ordinary microscope (C) is composed of proteins and lipids (D) is composed of calcium.

____24. Isotopes contain (A) more electrons than protons (B) more protons than neutrons (C) varying numbers of protons (D) varying numbers of electrons (E) varying numbers of neutrons.

____25. The general name for all of the living material in a cell is (A) protoplasm (B) cytoplasm (C) nucleoplasm (D) endoplasm.

____26. Osmosis is (A) limited to water passing through a selectively permeable membrane (B) the passage of fluids through an impermeable membrane (C) controlled by the nature of the membrane and the types of molecules in its environment (D) the passage of fluids through a fully permeable membrane.

____27. A chemical compound (A) has characteristics that are different from those of the elements that compose it (B) is an irreversible reaction (C) can be broken down by a physical means (D) may vary in its composition and still retain its characteristics.

____28. A colloidal suspension can be distinguished from a true solution by (A) dialysis (B) the Tyndall effect (C) evaporation (D) centrifugation.

____29. The number of protons in an atom is determined by its (A) atomic mass (B) atomic weight (C) atomic number (D) atomic energy.

____30. Which one of the following plays a key role in cell division? (A) ribosomes (B) mitochondria (C) DNA (D) endoplasmic reticulum (E) Golgi apparatus

____31. Which of the following is NOT a function of epithelial tissue? (A) protection (B) absorption (C) support (D) secretion

____32. The scientist who wrote an oath now taken by doctors was (A) Harvey (B) Galen (C) Hippocrates (D) Aristotle.

____33. The type of symmetry shown by the human body is (A) bilateral (B) radial (C) universal (D) asymmetrical.

Unit Outline
Grades 11, 12
Physiology
Unit: Body Framework

I. The Skeleton

A. Functions of skeleton
B. Structure of bone
  1. Epiphysis
  2. Diaphysis
C. Formation of bone
  1. Ossification
  2. Osteoblasts and osteoclasts
D. Joints
  1. Location
  2. Movement
E. Parts of the skeleton
  1. Axial skeleton
  2. Appendicular skeleton
F. Skeletal disorders

II. Muscle Physiology

A. Muscle structure
  1. Protein filaments
  2. Four bands
B. Chemistry of contraction -- chemical composition
C. Muscle twitch and tone
D. Effects of muscular exercise

III. Muscle Action

A. Movements at joints
B. Muscle attachments
C. Major muscles
  1. Origin
  2. Insertion
  3. Action

Suggested Activities
Grades 11, 12
Physiology
Unit: Body Framework

OBJECTIVE: To study the relationship of the striated muscle cells to the entire muscle and how the muscle is attached to structures affected during contraction

TITLE: "Muscle Structure"

SOURCE: Benson and Gunstream. Anatomy and Physiology Laboratory Textbook. W.C. Brown and Co., 1970.

OBJECTIVE: To determine the effects of heat and cold

TITLE: "Effect of Temperature on Muscular Contraction"

SOURCE: Morrison, et al. Experiments in Physiology. Holt, Rinehart, and Winston, 1972.

OBJECTIVE: To study effects of continual muscle use

TITLE: "The Effect of Fatigue on Muscles"

SOURCE: Morrison, et al. Experiments in Physiology. Holt, Rinehart, and Winston, 1972.

OBJECTIVE: To acquaint students with types of bones and anatomy of a long bone; to identify some of the main bones

TITLE: "The Skeletal Plan"

SOURCE: Benson and Gunstream. Anatomy and Physiology Laboratory Textbook. W.C. Brown and Co., 1970.

OBJECTIVE: To show the relationship of the different bones in the skull and to identify the main ones

TITLE: "The Skull"

SOURCE: Benson and Gunstream. Anatomy and Physiology Laboratory Textbook. W.C. Brown and Co., 1970.

OBJECTIVE: To acquaint students with regions of vertebral column and the anatomy of a single vertebra

TITLE: "The Vertebral Column"

SOURCE: Benson and Gunstream. Anatomy and Physiology Laboratory Textbook. W.C. Brown and Co., 1970.

OBJECTIVE: To identify the types of joints and the movements associated with them

TITLE: "Articulations"

SOURCE: Benson and Gunstream. Anatomy and Physiology Laboratory Textbook. W.C. Brown and Co., 1970.

OBJECTIVE: To understand functional relationship between skeletal muscle and bone

TITLE: "Muscles"

SOURCE: Morrison, et al. Experiments in Physiology. Holt, Rinehart, and Winston, 1972.

Resources
Grades 11, 12
Physiology
Unit: Body Framework

Text Materials

Benson, Harold J., and Gunstream, Stanley E. Anatomy and Physiology Laboratory Textbook. W.C. Brown and Co., 1970.

Chaffee and Greisheimer. Basic Physiology and Anatomy. J.B. Lippincott Co., 1969, pp. 57-186.

Morrison, et al. Experiments in Physiology. Holt, Rinehart, and Winston, 1972.

Morrison, et al. Human Physiology. Holt, Rinehart, and Winston, Inc., 1972.

Filmstrips -- High School Learning Center

The Body Machine -- Muscular System

Transparencies -- High School Learning Center

Actin-Myosin Filaments

Bones of Skull

Cross Section of Bone

Fetal Skull

Simple Twitch of Frog Muscle

Skeletal Muscles -- Anterior

Skeletal Muscles -- Posterior

The Skeleton

Spinal Column

Structure of Long Bone

Structure of Muscle

Exemplary Activity
Grades 11, 12
Physiology
Unit: Body Framework

Reference:

Benson, Harold J., and Gunstream, Stanley E. "The Skull," *Anatomy and Physiology Laboratory Textbook*. W.C. Brown and Co., 1970, pp. 54-58.

Evaluation Sample
Grades 11, 12
Physiology
Unit: Body Framework

Part I. Matching. Select the correct answer from column B.

A

____ 1. Action of bending arm at the elbow

____ 2. Enzyme at neuromuscular junction that causes contraction

____ 3. Decrease in muscle size from disuse

____ 4. Type of cell that forms bone

____ 5. An immovable type of joint

____ 6. The opposing action of pairs of closely associated muscles

____ 7. End of a muscle attached to a relatively immovable part of the body

____ 8. Lower extension of the breastbone

____ 9. Opening through which spinal cord communicates with the brain

____10. Channel through which bone is nourished

____11. Muscle that is unstriated, with a single nucleated cell

____12. The outer membranous covering of many bones

____13. Tissue active in forming red blood cells

____14. Projection of vertebra that limits movement of the vertebra above

____15. Fluid-filled cushion lubricating some joints

B

A. Haversian canal
B. involuntary muscle
C. bursa
D. periosteum
E. atrophy
F. foramen magnum
G. articular process
H. osteoblasts
I. cardiac
J. sacrum
K. transverse process
L. sarcolemma
M. medullary canal
N. extension
O. osteoclasts
P. xiphoid process
Q. marrow
R. cholinesterase
S. osteocytes
T. flexion
U. tarsals
V. hypertrophy
W. antagonistic
X. insertion
Y. acetylcholine
Z. origin

981

Evaluation Sample (Cont.)
Grades 11, 12
Physiology
Unit: Body Framework

Part II. Matching. Select the correct answer from column B.

A

____16. Muscle at back of upper arm

____17. Shoulder blade

____18. Small bone of lower leg

____19. Rear cranial bone

____20. Triangular muscle of upper back

____21. Large muscle of calf

____22. Rear seat bone of pelvis

____23. Neck region of spinal column

____24. Ankle bones

____25. Muscle connecting cheek bone to mandible

B

A. triceps brachii
B. tibia
C. latissimus dorsi
D. lumbar
E. masseter
F. ulna
G. biceps femoris
H. sternomastoideus
I. tarsals
J. occipital
K. carpals
L. pubis
M. scapula
N. gluteus maximus
O. sternum
P. gastrocnemius
Q. cervical
R. trapezius
S. fibula
T. ishium
U. parietal

Part III. Multiple Choice. Place letter of correct answer in blank.

____26. The muscle that is antagonistic to the gastrocnemius is the (A) biceps femoris (B) vastus medialis (C) tibialis anterior (D) soleus.

____27. The major point of insertion of the sternomastoideus is the (A) mandible (B) zygomatic (C) mastoid process (D) clavicle.

____28. The shoulder is an example of a __?__ joint. (A) ball and socket (B) suture (C) rotating (D) gliding (E) hinge

____29. In the morphology of a muscle fiber, the center band composed only of myosin is the __?__ band. (A) I (B) A (C) Z (D) H

____30. The shaft of a long bone is the (A) medullary (B) diaphysis (C) lamellae (D) epiphysis (E) trabecula.

____31. The state of normal partial contraction of a muscle tissue is called (A) tonus (B) tetanus (C) twitch (D) hypertrophy.

____32. Which one of the following muscles is NOT assocaited with arm movement? (A) deltoid (B) biceps brachii (C) pectoralis major (D) latissimus dorsi (E) trapezius

____33. Skeletal muscles contain (A) individual tapered cells (B) a single nucleus (C) sarcomeres (D) branched fibers.

Unit Outline
Grades 11, 12
Physiology
Unit: Nervous System

I. Nervous Coordination

   A. Central, peripheral, and autonomic branches
   B. Receptors and effectors
   C. Structure of neuron
   D. The nerve impulse
   E. Neural connections

II. Central Nervous System

   A. Spinal cord
      1. Membrane covering
      2. White matter and gray matter
   B. Spinal nerves
      1. Names and number
      2. Roots
   C. Reflex action
   D. The brain
      1. Embryonic development
      2. Divisions and functions
   E. Cranial nerves
   F. Conditioned reflex
   G. Autonomic nervous system -- two divisions

III. The Eye

   A. Structure of the eye
      1. Orbital cavity
      2. Muscles of the eye
      3. Protection of the eye
      4. Parts of the eyeball
      5. Physics of vision

IV. Vision

   A. Retinal image, binocular vision, spatial relationships
   B. Night vision -- rods and rhodopsin
   C. Color vision
      1. Cones -- three primary colors
      2. Wave lengths of light
      3. Characteristics of color vision
      4. Color blindness
   D. Visual defects

V. The Ear

- A. External ear
- B. Middle ear
    - 1. Three bones
    - 2. Eustachian tube
- C. Inner ear
    - 1. Vestibule
    - 2. Cochlea
    - 3. Semicircular canals
- D. Nature of sound
- E. Balance
- F. Auditory defects

Suggested Activities
Grades 11, 12
Physiology
Unit: Nervous System

OBJECTIVE: To understand how the body responds automatically to external stimuli; to study the reflex arc and identify the anatomy of a neuron

TITLE: "The Reflex Mechanism"

SOURCE: Benson and Gunstream. Anatomy and Physiology Laboratory Textbook. W.C. Brown and Co., 1970.

OBJECTIVE: To make a comparative study of the sheep brain and human brain; to locate and identify some major cranial nerves

TITLE: "Brain Anatomy: External and Internal"

SOURCE: Benson and Gunstream. Anatomy and Physiology Laboratory Textbook. W.C. Brown and Co., 1970.

OBJECTIVE: To study and compare the anatomy of a sheep eye with a human eye

TITLE: "The Eye"

SOURCE: Benson and Gunstream. Anatomy and Physiology Laboratory Textbook. W.C. Brown and Co., 1970.

OBJECTIVE: To show visually the problems faced by colorblind persons

TITLE: "Color Blindness"

SOURCE: Morrison, et al. Experiments in Physiology. Holt, Rinehart, and Winston, 1972.

OBJECTIVE: To study the role of the ear in hearing and equilibrium

TITLE: "Hearing and Balance"

SOURCE: Morrison, et al. Experiments in Physiology. Holt, Rinehart, and Winston, 1972.

Resources
Grades 11, 12
Physiology
Unit: Nervous System

Text Materials

Benson, Harold J., and Gunstream, Stanley E. Anatomy and Physiology Laboratory Textbook. W.C. Brown and Co., 1970.

Chaffee and Greisheimer. Basic Physiology and Anatomy. J.B. Lippincott Co., 1969, pp. 187-295.

Morrison, et al. Experiments in Physiology. Holt, Rinehart, and Winston, 1972.

Morrison, et al. Human Physiology. Holt, Rinehart, and Winston, Inc., 1972, pp. 103-182.

Films -- Columbus Public Library

The Ears and Hearing

The Eyes and Their Care

Frontiers of the Mind

Fundamentals of the Nervous System

Human Brain

Light and Color

Filmstrips -- High School Learning Center

The Eyes and Their Care

Men's Senses in Action

Slides With Cassette -- High School Learning Center

The Central Nervous System

Transparencies -- High School Learning Center

Autonomic Divisions

Brain -- Cross Section

Transparencies (Cont.)

- Brain -- External
- Comparison of Vertebrate Brains
- Ear
- Embryological Development of Brain
- Eye -- Cross Section
- Eye Defects
- Muscles of the Eye
- Organ of Corti
- Physiology of CNS (set of 16)
- Reflex Arc
- Regions of Spinal Cord
- Retina -- Rods and Cones
- Sensory and Motor Neurons
- Spinal Cord -- Coverings
- Structure of Neuron
- Transmission of Nerve Impulse
- Types of Neurons

Exemplary Activity
Grades 11, 12
Physiology
Unit: Nervous System

Reference:

Benson, Harold J., and Gunstream, Stanley E. "Brain Anatomy: External," Anatomy and Physiology Laboratory Textbook. W.C. Brown and Co., 1970, pp. 120-132.

Evaluation Sample
Grades 11, 12
Physiology
Unit: Nervous System

Chapters 8 and 9
Section I. Multiple Choice

____ 1. Which of the following is not a structural feature of a neuron? (A) Nissl body (B) neurofibrils (C) axon (D) dendrite (E) synapse

____ 2. Injured nerve fibers within the brain and spinal cord do not regenerate because they lack (A) myelin (B) neurilemma (C) axis cylinders (D) posterior roots.

____ 3. The point of contact between a nerve fiber and a muscle or gland is called the (A) exteroceptor (B) neuroeffector junction (C) associative neuron (D) synapse.

____ 4. Ganglia are (A) groups of cell bodies (B) receptors (C) effectors (D) nerve fibers.

____ 5. Visceral afferent fibers are to the brain and spinal cord as visceral efferent fibers are to (A) glands and smooth muscles (B) skeletal muscles and glands (C) cardiac muscle and skeletal muscle (D) skeletal muscles (E) none of these.

____ 6. Sensory cell bodies are to posterior root ganglia as motor cell bodies are to (A) posterior horns of gray matter (B) ventral root ganglia (C) posterior tracts of white matter (D) anterior horns of gray matter (E) all of these.

____ 7. The nuclei of the cells that conduct the impulse in a nerve are located in the (A) sheath surrounding each fiber (B) the organs innervated by the nerve (C) the cyton of the nerve (D) the periphery of the nerve.

____ 8. Which of the following activities in man is NOT a purely automatic response? (A) circulation of blood (B) knee-jerk reflex (C) maintaining equilibrium (D) maintaining good posture (E) respiration

____ 9. At a synapse the (A) adjoining cells are in contact (B) impulse passes from one dendrite to another (C) impulse passes from an axon to a dendrite (D) impulse passes from a dendrite to an axon.

____10. The part of a neuron that transmits the impulse away from the cell body is the (A) cyton (B) Nissl body (C) dendrite (D) axon.

____11. There are ___?___ pairs of nerves extending from the cervical region of the spinal cord. (A) 12 (B) 8 (C) 5 (D) 1

____12. The cranial nerve associated with the sense of smell is the (A) optic (B) glossopharyngeal (C) olfactory (D) trochlear (E) hypoglossal.

____13. The following function would be under the control of the corpora quadrigemmina: (A) visceral activities (B) heartbeat (C) reasoning (D) regulation of movements of head and eyes in response to sound or light (E) body balance.

____14. The minimum strength of a stimulus needed to initiate a nerve impulse is called the (A) summation (B) action potential (C) the all-or-none law (D) threshold.

____15. The grooves or creases that cover the surface layer of the brain are known as (A) septums (B) convolutions (C) ventricles (D) aqueducts (E) fissures.

____16. Which of the following would you expect to observe in a patient with a tumor of the cerebellum? (A) inability to execute any voluntary movements (B) inability to coordinate various muscular movements (C) inability of the heart to continue normal beating (D) loss of general sensation

____17. The fissure of Sylvius is located between the (A) frontal and parietal lobes (B) two halves of the cerebrum (C) pons and cerebellum (D) frontal and temporal lobes (E) cerebrum and cerebellum.

____18. A business executive became very nervous and began to perspire and breathe rapidly on learning that he was to be investigated by the IRS. This action was the result of a (A) conditioned reflex (B) learned response (C) inborn response (D) instinct (E) simple reflex action.

____19. The tract of the spinal cord that contains ascending fibers only and carries sensations of touch to the brain is the (A) posterior column (B) anterior column (C) lateral column.

____20. Many of these tracts carry impulses from the right side of the body to the left side of the brain and vice versa. The crossing of these fiber tracts occurs in the pyramids of the (A) pons (B) midbrain (C) thalamus (D) medulla.

Section II. True or False

____21. Motor neurons conduct the impulse away from the GNS.

____22. The parasympathetic branch of the autonomic nervous system is responsible for preparing the body for sudden emergencies.

____23. The area of the brain immediately anterior to the fissure of Rolando is the motor area controlling the voluntary muscles of much of the body.

____24. In the electro-chemical changes that occur during the transmission of an impulse, the proteins of the fiber are changed to ammonia.

____25. The spinal cord enters the skull to join with the brain through the foramen magnum.

____26. In a normal unstimulated nerve fiber, the concentration of the Na^+ is higher on the outside of the membrane.

____27. In the embryonic development of the nervous system, the spinal cord develops in the most posterior portion of the neural canal.

____28. There is a total of twelve pairs of cranial nerves in the human.

____29. Those receptors that respond to changes in the external environment are called proprioceptors.

____30. The diencephalon is the major portion of the midbrain.

____31. The anterior roots of the spinal cord carry afferent fibers into the cord.

____32. The tough, protective outer covering membrane of the brain and spinal cord is the pia mater.

____33. The portion of a reflex arc that is most readily affected by alcohol and drugs is the associative neuron.

Unit Outline
Grades 11, 12
Physiology
Unit: Digestive System

I. Foods

- A. Nutrient requirements -- uses of foods
- B. Food materials
  - 1. Inorganic nutrients -- water, mineral salts, vitamins
  - 2. Organic nutrients -- carbohydrates, lipids, proteins
    - a. Composition
    - b. Classification
    - c. Tests
    - d. Uses
- C. The diet
  - 1. Ingestion and digestion
  - 2. Calories (C) vs. calories (c)

II. Enzymes and Vitamins

- A. Enzyme action
  - 1. Organic catalyst
  - 2. Coenzymes
  - 3. Environmental effects
- B. Vitamins
  - 1. Oil soluble -- classification, source, uses
  - 2. Water soluble -- classification, source, uses

III. The Mouth

- A. Structures of mouth
- B. Divisions of pharynx
- C. Tongue
  - 1. Functions
  - 2. Regions of taste
  - 3. Senses of smell and taste
- D. Teeth
  - 1. Deciduous and permanent
    - a. Identification
    - b. Function
  - 2. Formation and structure
- E. Digestion
  - 1. Mechanical
  - 2. Chemical -- salivary glands
- F. Deglutition
  - 1. Muscles
  - 2. Channels
  - 3. Peristalsis

IV. The Stomach

- A. Structure
  - 1. Sphincters
  - 2. Regions
  - 3. Muscles of wall
- B. Gastric glands
  - 1. pH
  - 2. Types of cells
  - 3. Chemical secretions and uses
- C. Control of glandular secretions
  - 1. Chemical
  - 2. Nervous
- D. Stomach movements

V. Lower Digestive Tract

- A. Liver
  - 1. Structure
  - 2. Bile formation
  - 3. Portal circulation
  - 4. Other functions
- B. Pancreas
  - 1. Structure
  - 2. Secretions and functions
  - 3. Islets of Langerhans
- C. Small intestine
  - 1. Duodenum
  - 2. Jejunum
  - 3. Ileum
    - a. Glands
    - b. Secretions
    - c. Uses
- D. Colon
  - 1. Main divisions
  - 2. Functions
- E. Rectum and anus -- nerve and muscle control

Suggested Activities
Grades 11, 12
Physiology
Unit: Digestive System

OBJECTIVE: To determine the presence of the basic food nutrients in common foods

TITLE: "Analysis of Foods"

SOURCE: Morrison, et al. Experiments in Physiology. Holt, Rinehart, and Winston, 1972, pp. 33-35.

OBJECTIVE: To make a comparative study of digestive organs of sheep and man; to identify parts of digestive system

TITLE: "Anatomy of Digestive System"

SOURCE: Benson and Gunstream. Anatomy and Physiology Lab Textbook. W.C. Brown and Co., 1970.

Resources
Grades 11, 12
Physiology
Unit: Digestive System

Text Materials

Benson and Gunstream. Anatomy and Physiology Laboratory Textbook. W.C. Brown and Co., 1970.

Chaffee and Greisheimer. Basic Physiology and Anatomy. J.B. Lippincott Co., 1969, pp. 453-497.

Morrison, et al. Experiments in Physiology. Holt, Rinehart, and Winston, 1972.

Morrison, et al. Human Physiology. Holt, Rinehart, and Winston, Inc., 1972, pp. 183-255.

Films -- Columbus Public Library

The Alimentary Tract

Fundamentals of Diet

Understanding Vitamins

Filmstrips -- High School Learning Center

Digestion of Foods

Gastro-Intestinal Tract (3 with cassettes)

The Teeth

Transparencies -- High School Learning Center

Absorption Through Villi

Anatomy of Colon

Anatomy of Digestive System

Anatomy of Neck

Anatomy of Small Intestine

Anatomy of Stomach

Transparencies (Cont.)

- The Mouth
- Regions of Tongue
- Structure of a Tooth

Exemplary Activity
Grades 11, 12
Physiology
Unit: Digestive System

Reference:

Morrison, et al. "Analysis of Foods," Experiments in Physiology. Holt, Rinehart, and Winston, 1972.

Evaluation Sample
Grades 11, 12
Physiology
Unit: Digestive System

Chapters 13-17
Section I. Multiple Choice. Place letter of correct answer in blank.

____ 1. Salt sensations stimulate the taste buds at the __?__ of the tongue. (A) sides (B) tip (C) front and sides (D) back

____ 2. A substance, to qualify as a food, must (A) contain calcium (B) contain nitrogen (C) repair or replace protoplasm (D) be enjoyable.

____ 3. Organic compounds differ from inorganic compounds in that organic compounds (A) cannot be found in living organisms (B) are insoluble in water (C) always contain carbon and nitrogen (D) always contain carbon and hydrogen.

____ 4. Salivary digestion (A) is primarily concerned with the breakdown of starch (B) results in the digestion of most fats (C) creates a basic medium for protein digestion (D) produces a fluid called chyme.

____ 5. If a person holds his nose while eating peppermint candy, (A) the candy will have no flavor (B) it will have a sour flavor (C) he will taste sugar (D) he will taste peppermint flavor.

____ 6. A normal set of deciduous teeth (A) contains a total of 32 teeth (B) lacks premolar teeth (C) contains four different kinds of teeth (D) lacks molar teeth.

____ 7. Gastric juice (A) contains an enzyme that digests protein (B) is slightly alkaline in its reaction (C) continues the digestion of carbohydrates (D) simply moistens the food.

____ 8. The four most common chemical elements present in foods are (A) iron, oxygen, sulfur, water (B) carbon, oxygen, nitrogen, calcium (C) oxygen, nitrogen, hydrogen, carbon (D) carbon, hydrogen, oxygen, chlorine.

____ 9. Swallowing (A) is purely voluntary in its nature (B) is partly voluntary and partly involuntary (C) is under involuntary control only (D) is the result of the contraction of striated muscles.

____10. The organic nutrient from which the caloric value is released most readily is (A) sugar (B) fat (C) protein (D) minerals.

____11. Tooth dentine is formed by (A) orthodontists (B) ameloblasts (C) odontoclasts (D) odontoblasts.

____12. Canine teeth are best suited for (A) tearing (B) grinding (C) crushing (D) biting.

____13. The outer covering of the stomach is called (A) gastric mucosa (B) rugae (C) parietal cells (D) peritoneum (E) greater omentum.

____14. Cells in the duodenal region of the digestive tract secrete the hormone (A) pepsin (B) insulin (C) gastrin (D) secretin.

____15. The gland located at the junction of the stomach and the duodenum is the (A) spleen (B) pancreas (C) liver (D) parotid.

____16. The intestinal enzymes are produced in special glands called the (A) haustrae (B) Kupffer (C) Crypts of Lieberkuhn (D) spiral valves of Heister.

____17. Minerals are used primarily for (A) building protoplasm (B) energy (C) food storage (D) regulating body activities.

____18. The main portion of the throat cavity is the (A) laryngealpharynx (B) soft palate (C) oralpharynx (D) nasopharynx.

____19. The muscular membrane that protects the opening into the upper throat cavity is the (A) epiglottis (B) greater omentum (C) uvula (D) soft palate.

____20. Which of the following is NOT considered to be an accessory organ of digestion? (A) esophagus (B) liver (C) teeth (D) tongue

____21. The terminal portion of the large intestine is the (A) caecum (B) transverse colon (C) descending colon (D) ascending colon.

____22. The Islets of Langerhans are concerned with the production of (A) gastrin (B) insulin (C) erepsin (D) pancreatic juice.

____23. Monosaccaride is to glucose as disaccharide is to (A) galactose (B) glycogen (C) dextrose (D) lactose.

____24. The gastric enzyme that digests the casein in milk is (A) maltase (B) trypsin (C) lactase (D) rennin (E) pepsin.

____25. The pH of pancreatic juice is about (A) 1.7 (B) 3 (C) 6.7 (D) 7.5.

Evaluation Sample (Cont.)
Grades 11, 12
Physiology
Unit: Digestive System

Section II. True or False. Write T (true) or F (false) in the blank.

____26. The lower end of the stomach opens into the small intestine through the cardiac orifice.

____27. The chemical used in the test for simple sugars was Benedict's solution.

____28. The hepatic artery supplies the liver with fresh oxygenated blood.

____29. Cholesterol is a representative of the phospholipids.

____30. Pancreatic lipase splits emulsified fats to glycerol and fatty acids.

____31. The first portion of the stomach into which the food enters is the fundus.

____32. Digestion is accomplished by the biological process called dehydration synthesis.

____33. The salivary glands located beneath the lower point of the ear are the parotids.

____34. The membrane by which cementum bonds a tooth to the jawbone is the periodontal.

____35. A preliminary step to the formation of urea in the liver is the deamination of amino acids.

____36. Bile is stored in the ball bladder by passing out through the cystic duct and into the gall bladder through the hepatic duct.

____37. In man, the chief pigment in bile is the red pigment, bilirubin.

____38. The absorption of the end products of protein digestion is accomplished by diffusion into the blood capillaries of the villus.

____39. Nitrogen is an element found in proteins but no other organic compound.

____40. In a saturated fat, the number of hydrogen atoms doubles the number of oxygen atoms.

Unit Outline
Grades 11, 12
Physiology
Unit: Respiratory System

I. Respiratory Structures

- A. Respiration in man
    - 1. External
    - 2. Internal
- B. Nasal cavities
    - 1. Structure
    - 2. Nerve functions
- C. Pharynx
    - 1. Glottis
    - 2. Epiglottis
- D. Larynx
    - 1. Structure
    - 2. Location
    - 3. Function
- E. Trachea and bronchi
- F. Lungs

II. Mechanics of Breathing

- A. Inspiration and expiration
- B. Nervous control
- C. Muscle action
- D. Air pressure

III. Lung Capacity

- A. Total and vital
    - 1. Tidal air
    - 2. Complemental air
    - 3. Supplemental air

IV. Transport of Gases

- A. Oxygen
    - 1. Red cells
    - 2. Hemoglobin
- B. Carbon dioxide
    - 1. Plasma
    - 2. $NaHCO_3$
    - 3. $KHCO_3$

Suggested Activities
Grades 11, 12
Physiology
Unit: Respiratory System

OBJECTIVE: To compare organs of sheep with organs of man and identify

TITLE: "The Respiratory Organs"

SOURCE: Benson and Gunstream. Anatomy and Physiology Laboratory Textbook. W.C. Brown and Co., 1970.

OBJECTIVE: To study the basic principles of the mechanics of breathing and the measurements of the volumes of air involved

TITLE: "Breathing: Mechanics and Spirometry"

SOURCE: Benson and Gunstream. Anatomy and Physiology Laboratory Textbook. W.C. Brown and Co., 1970.

Resources
Grades 11, 12
Physiology
Unit: Respiratory System

Text Materials

Benson, Harold J., and Gunstream, Stanley E. Anatomy and Physiology Laboratory Textbook. W.C. Brown and Co., 1970.

Chaffee and Greisheimer. Basic Physiology and Anatomy. J.B. Lippincott Co., 1969, pp. 415-452.

Morrison, et al. Human Physiology. Holt, Rinehart, and Winston, 1972, pp. 256-289.

Films -- Columbus Public Library

How the Body Uses Energy

Filmstrips -- High School Learning Center

Mechanisms of Breathing

Respiration (2 with cassettes)

Transparencies -- High School Learning Center

Anatomy of the Lung

Nervous Control of Respiration

The Respiratory System

Upper Respiratory Organs

Exemplary Activity
Grades 11, 12
Physiology
Unit: Respiratory System

Reference:

Benson, Harold J., and Gunstream, Stanley E. "The Respiratory Organs," Anatomy and Physiology Laboratory Textbook. W.C. Brown and Co., 1970, pp. 188-191.

Evaluation Sample
Grades 11, 12
Physiology
Unit: Respiratory System

Chapter 18

1. The _______________ is the proper name for the voice box.

2. The opening through which air enters this structure is called the _________________.

3. The ________________ membrane covers the lungs and protects them.

4. The oxygen-carrying pigment in man is called __________________.

5. It is a compound formed of the element _______________ that makes it red.

6. During a normal relaxed breath, (a)____________ cc of air called the (b)____________ air will be exchanged.

7. After the release of this normal breath, an additional (a)_________ cc of air could be expelled. This is known as the (b)____________ air.

8. The inner folds or ridges of the nasal cavity are called the _____________.

9. In which of these ridges, by name, are the receptors of the olfactory nerve located? ____

10. The main tube carrying air from the pharynx is biologically known as the __________________.

11. This tube then branches into two _____________, one passing to each lung.

12. The ______________ are the minute air sacs in the lungs.

13. The _______________ is the large muscular membrane that separates the thoracic and abdominal cavities.

14. Air moves into the lungs during the breathing phase called ____________.

15. This is because the thoracic cavity is enlarged by muscular actions resulting from nerve impulses carried along the ____________ nerves.

16. The actual movement of the air is caused by ______________.

17. In what part of the blood is most of the CO_2 transported? ______________

18. By what chemical compound, or in what form, is the CO_2 being transported?

____

19. What enzyme is responsible for the change of the CO_2 into this more complex compound? ______________________________

20. All of these activities related to respiration are under the control of a respiratory center located in the __________________.

Unit Outline
Grades 11, 12
Physiology
Unit: Circulatory System

I. Internal Transport

- A. Body fluids
  - 1. Intracellular
  - 2. Intravascular
  - 3. Intercellular
- B. Functions of blood
- C. Composition of blood
  - 1. Plasma
  - 2. Solid portions
- D. Circulation -- closed system
  - 1. Arteries, veins, capillaries
  - 2. Four-chambered heart

II. Blood Solids

- A. Functions of bone marrow
  - 1. Red marrow
  - 2. Yellow marrow
- B. Erythrocytes
  - 1. Formation
  - 2. Structure
  - 3. Function
- C. Leukocytes and lymphocytes
  - 1. Formation
  - 2. Structure
  - 3. Function
- D. Thrombocytes
  - 1. Formation
  - 2. Structure
  - 3. Function
- E. Blood deficiencies
  - 1. Anemia
  - 2. Leukemia
  - 3. Sickle cell anemia
  - 4. Pernicious anemia

III. Blood Plasma

- A. Composition
- B. Coagulation of blood
  - 1. Blood clotting factors
  - 2. Irregular blood conditions
- C. Thymus and immunity
- D. Blood typing
  - 1. Four blood groups
  - 2. Rh factor
  - 3. Transfusions

IV. The Heart

- A. Structure
  - 1. Muscle wall and membranes
  - 2. Four chambers and functions
  - 3. Valves of heart
  - 4. Cardiac cycle
- B. Control of heartbeat
  - 1. Sinoatrial node
  - 2. Atrioventricular node
  - 3. Bundle of His
  - 4. Purkinje network
- C. Chemical control
  - 1. Atropine
  - 2. Muscarine
  - 3. Nicotine
  - 4. Adrenalin
  - 5. Noradrenalin
- D. Heart sounds

V. Circulation of Body Fluids

- A. Structure of vessels
  - 1. Arteries
  - 2. Capillaries
  - 3. Veins
- B. Blood pressure
  - 1. Factors affecting pressure
  - 2. Measurement of pressure
- C. Pulse
  - 1. Pulse wave
  - 2. Blood wave
- D. Blood distribution control
  - 1. Vasoconstrictor center
  - 2. Vasodilator center
- E. Branches of circulation
  - 1. Pulmonary
  - 2. Systemic
    - a. Arteries
    - b. Veins
- F. Lymphatic system
  - 1. Lymph capillaries
  - 2. Lymph ducts
  - 3. Lymph nodes

Suggested Activities
Grades 11, 12
Physiology
Unit: Circulatory System

OBJECTIVE: To observe and understand the structures of the different cells

TITLE: "The Structure of Blood Cells"

SOURCE: Morrison, et al. Experiments in Physiology. Holt, Rinehart, and Winston, 1972.

OBJECTIVE: To acquaint students with instruments and procedures for counting red or white cells

TITLE: "Blood Cell Counting"

SOURCE: Benson and Gunstream. Anatomy and Physiology Laboratory Textbook. W.C. Brown and Co., 1970.

OBJECTIVE: To show how blood types are determined and the importance of those factors in blood transfusions and childbirth

TITLE: "Blood Typing"

SOURCE: Morrison, et al. Experiments in Physiology. Holt, Rinehart, and Winston, 1972.

OBJECTIVE: To observe the structure of the human heart by a comparative study with a sheep heart

TITLE: "Anatomy of the Heart"

SOURCE: Benson and Gunstream. Anatomy and Physiology Laboratory Textbook. W.C. Brown and Co., 1970.

OBJECTIVE: To study the sounds of the heart; to study the normal rate of the heartbeat and the effect of exercise on the rate of the beat

TITLE: "Heart Action and Circulation"

SOURCE: Morrison, et al. Experiments in Physiology. Holt, Rinehart, and Winston, 1972.

OBJECTIVE: To observe the proper method of measuring blood pressure and to understand the roles of arterial pressure and venous pressure in maintaining circulation

TITLE: "Blood Pressure"

SOURCE: Morrison, et al. Experiments in Physiology. Holt, Rinehart, and Winston, 1972.

Resources
Grades 11, 12
Physiology
Unit: Circulatory System

Text Materials

Benson, Harold J., and Gunstream, Stanley E. Anatomy and Physiology Laboratory Textbook. W.C. Brown and Co., 1970.

Chaffee and Greisheimer. Basic Physiology and Anatomy. J.B. Lippincott Co., 1969, pp. 296-414.

Morrison, et al. Experiments in Physiology. Holt, Rinehart, and Winston, 1972.

Morrison, et al. Human Physiology. Holt, Rinehart, and Winston, 1972, pp. 290-355.

Films -- Columbus Public Library

The Blood

Heart Disease

Human Body Circulatory System

A Matter of Time

Filmstrips -- High School Learning Center

Circulation (3 with cassettes)

The Heart and Circulation

How the Heart Works

Transparencies -- High School Learning Center

Anatomy of the Heart

Arteries of the Body

Blood Clotting

Blood Supply of Heart

Blood Typing

Comparison of Vertebrate Hearts

Transparencies (Cont.)

Development of Blood Cells

Lymphatic System

Nerve Supply of Heart

Open and Closed Systems

Physiology of the Heart (set of 13)

Veins of the Body

Exemplary Activity
Grades 11, 12
Physiology
Unit: Circulatory System

Reference:

Benson, Harold J., and Gunstream, Stanley E. "Anatomy of the Heart," Anatomy and Physiology Laboratory Textbook. W.C. Brown and Co., 1970, pp. 158-161.

Evaluation Sample
Grades 11, 12
Physiology
Unit: Circulatory System

Chapters 21-25
Multiple Choice.

____ 1. The blood is aerated in the (A) systemic system (B) pulmonary system (C) lymphatic system (D) hepatic portal system (E) coronary system.

____ 2. The tricuspid valve lays (A) between the right and left atria (B) between right and left ventricles (C) between the two left chambers (D) between the two right chambers (E) at entrance to the aorta (F) at entrance to the pulmonary artery.

____ 3. Which one of the following is present in walls of both arteries and capillaries? (A) connective tissue (B) muscle tissue (C) endothelial tissue (D) adipose tissue (E) epithelial tissue

____ 4. It is believed that those suffering from the hereditary disease in which the blood is slow to clot have this condition because (A) the platelets are not fragile (B) they lack vitamin K (C) they lack sufficient Ca (D) they lack prothrombin (E) they lack thromboplastin.

____ 5. The sinus node in man (A) is the initiator of the heartbeat (B) is a receptacle for blood entering the heart (C) is a nerve center in the head (D) is one of the cavities in the head.

____ 6. Oxygen is carried in the blood by the (A) lymph (B) erythrocytes (C) thrombocytes (D) plasma (E) monocytes.

____ 7. The vitamin necessary for normal clotting of blood is (A) A (B) B-6 (C) B-12 (D) E (E) K.

____ 8. Indicate the best response with respect to function of lymph system: (A) provides moist environment for cells (B) it aids in disease prevention (C) it transports fats (D) it facilitates diffusion of substances in and out of cells (E) more than one of the above.

____ 9. Clotting of newly drawn blood would be prevented by (A) prothrombin (B) heparin (C) fibrinogen (D) thromboplastin (E) none of the above.

____10. Which of the following leukocytes are most numerous in normal blood? (A) lymphocytes (B) eosinophils (C) basophils (D) neutrophils

____11. Arteries may be defined as vessels (A) carrying oxygenated blood (B) carrying deoxygenated blood (C) carrying blood toward the heart (D) carrying blood away from the heart (E) more than one of these.

____12. The human heart is enclosed in a membranous sac called the (A) peritoneum (B) pleural sac (C) periosteum (D) pericardium.

____13. Portal circulation includes the portion of the systemic circulation that flows from the digestive regions to the liver and then to the (A) spleen (B) heart (C) lungs (D) stomach (E) kidneys.

____14. White blood cells differ from red in many ways. In which respect are they alike? (A) they are self-propelling (B) they lack hemoglobin (C) they circulate in the plasma (D) they have organized nuclei (E) primary functions are to combat infections

____15. The type of blood determined by no agglutination in Anti-A serum but agglutination in Anti-B serum is (A) type A (B) type B (C) type AB (D) type O.

____16. The specific gravity of blood refers to its weight compared with that of (A) plasma (B) red blood cells (C) water (D) tissue fluid.

____17. The first phase of blood clotting involves the formation of (A) prothrombin (B) thrombin (C) fibrinogen (D) thromboplastic.

____18. The semilunar valve of the aorta opens when (A) the ventricle is in diastole (B) arterial pressure is lower than ventricular pressure (C) the atrium is in systole (D) none of these.

____19. The fluid portion of the blood is (A) platelets (B) erythrocytes (C) plasma (D) leukocytes.

____20. An increase in the pressure of blood entering the right atrium will result in (A) chemoreceptor stimulation (B) stimulation of cardioaccelerator center (C) stimulation of the cardio-inhibitory center (D) depression of the cardioaccelerator center.

____21. Erythrocytes are to red bone marrow as lymphocytes are to (A) white bone marrow (B) lymph nodes and spleen (C) liver and kidney (D) lungs (E) none of these.

____22. Right atrium is to venae cavae as left atrium is to (A) pulmonary veins (B) coronary artery (C) aorta (D) pulmonary artery (E) none of these.

____23. The flow of blood through the capillaries (A) is controlled by the precapillary sphincters (B) is faster than in the venules (C) is faster than in the arterioles (D) passes from venules to arterioles (E) does not affect the shape of the corpuscles.

Evaluation Sample (Cont.)
Grades 11, 12
Physiology
Unit: Circulatory System

____24. Blood pressure (A) is partly maintained by pumping action of the heart (B) decreases when exercising (C) rises during sleep (D) increases when ventricles are in diastole (E) decreases when ventricles are in systole.

____25. The lymph (A) is the same as the plasma of the blood (B) lacks inorganic salts (C) is the same as the intracellular fluids (D) returns to the blood (E) is forced around the body by the heart.

____26. The blood serum containing antibodies against disease is the (A) albumin (B) globulin (C) fibrinogen (D) hemoglobin.

____27. Oxygenated blood flows through veins of (A) pulmonary circulation (B) systemic circulation (C) renal circulation (D) portal circulation (E) coronary circulation.

____28. Blood returning from the legs enters the heart through the (A) left atrium (B) right atrium (C) left ventricle (D) right ventricle.

____29. Complications from the Rh factor would be most likely to occur in the development of an (A) Rh^+ child and Rh^+ mother (B) Rh^+ child and Rh^- mother (C) Rh^- child and Rh^+ mother (D) Rh^- child and Rh^- mother.

____30. A sudden rise in the white cell count could indicate (A) failure of blood to clot (B) an infection in the tissues (C) an Rh complication (D) a lack of hemoglobin.

____31. The fluid within the cells is (A) extracellular (B) intracellular (C) intravascular (D) intercellular.

____32. The only blood cells normally found outside of the blood vessels are (A) erythrocytes (B) reticulocytes (C) leukocytes (D) thrombocytes.

____33. Of the following, the only cells NOT concerned with blood forming functions: (A) reticular cells (B) megakaryocytes (C) normoblasts (D) eosinophils.

____34. The iliac arteries supply blood to (A) the shoulder region (B) the kidney (C) the intestines (D) the stomach (E) the legs.

____35. The heart is divided into two halves by the (A) foramen ovalis (B) foramen magnum (C) septum (D) sacrum (E) A-V bundle.

____36. The muscular layer of an artery is the (A) tunica intima (B) tunica albuginea (C) tunica externa (D) tunica media.

____37. As a person ages, his blood pressure (A) increases (B) decreases (C) remains the same (D) varies widely.

____38. The lymph reenters the blood system at the (A) innominate vein (B) superior vena cava (C) dorsal aorta (D) portal vein.

____39. The Rh antigen is found in about __?__ % of the U.S. population. (A) 45 (B) 55 (C) 70 (D) 85 (E) 92

____40. Hemoglobin is a compound of globin and heme that is formed of (A) calcium (B) iron (C) copper (D) ATP.

Unit Outline
Grades 11, 12
Physiology
Unit: Excretory System

I. The Skin

- A. Integumentary system
- B. Functions of skin
- C. Structure of skin
- D. Appendages of skin
- E. Sense receptors in skin

II. The Kidneys

- A. Functions of kidneys
- B. Structure of kidneys
  - 1. Medulla and cortex
  - 2. Blood supply
- C. Other excretory structures
- D. Filtration process
- E. Organic excretory products
- F. Abnormal conditions

Suggested Activities
Grades 11, 12
Physiology
Unit: Excretory System

OBJECTIVE: To compare the sheep and human kidney

TITLE: "The Structure of the Mammalian Kidney"

SOURCE: Morrison, et al. Experiments in Physiology. Holt, Rinehart, and Winston, 1972.

Text Materials

Benson, Harold J., and Gunstream, Stanley E. Anatomy and Physiology Laboratory Textbook. W.C. Brown and Co., 1970.

Chaffee and Greisheimer. Basic Physiology and Anatomy. J.B. Lippincott Co., 1969, pp. 48-55, 521-545.

Morrison, et al. Experiments in Physiology. Holt, Rinehart, and Winston, 1972.

Morrison, et al. Human Physiology. Holt, Rinehart, and Winston, 1972, pp. 356-396.

Films -- Columbus Public Library

Work of the Kidneys

Transparencies -- High School Learning Center

Anatomy of the Kidney

The Nephron

The Skin -- Cross Section

Exemplary Activity
Grades 11, 12
Physiology
Unit: Excretory System

Reference:

Benson, Harold J., and Gunstream, Stanley E. "The Urinary System," Anatomy and Physiology Laboratory Textbook. W.C. Brown and Co., 1970, pp. 217-220.

Evaluation Sample
Grades 11, 12
Physiology
Unit: Excretory System

Chapters 26-29
Section I. Matching.

____ 1. Region where blood vessels enter and leave kidney

____ 2. Terminal portion of nephron unit

____ 3. The main pigment in the skin or hair

____ 4. Result of the action of the arrector pilae muscle

____ 5. Nonliving material that replaces protoplasm of cells in outer epidermis

____ 6. Layer of protective material composed of lipids and water

____ 7. Localized outward thickening of the outer epidermal layer

____ 8. Lack of color pigments in the skin

____ 9. Presence of excess sugar in urine

____10. Part of the hair strand containing pigment

A. boundary membrane
B. acne
C. cuticle
D. keratin
E. corn
F. albuminuria
G. hilum
H. glycosuria
I. cortex
J. barrier layer
K. goose flesh
L. proximal convoluted tubule
M. albinism
N. hemoglobin
O. callus
P. distal convoluted tubule
Q. nephritis
R. melanin

Section II. Multiple Choice.

____11. Which of the following glomerular filtrate constituents is completely reabsorbed regardless of its concentration? (A) glucose (B) amino acids (C) sodium (D) creatinine (E) none of these

____12. The chief organic constituent of urine is (A) albumin (B) uric acid (C) urea (D) ammonia.

____13. The maintenance of a relatively high blood pressure in the glomerulus is related to the fact that (A) the afferent arteriole arises from the renal artery (B) the efferent arteriole is larger than the afferent arteriole (C) the glomerulus is larger than the afferent arteriole (D) the afferent arteriole is larger than the efferent arteriole.

____14. Touch is to Meissner's corpuscles as cold is to (A) corpuscles of Vater-Pacini (B) free nerve endings of hair follicles (C) end organs of Ruffini (D) end organs of Krause.

____15. Blackheads result from a blocking of the secretions of (A) sweat glands (B) ceruminous glands (C) sebaceous glands (D) lacrimal glands.

____16. Which of the following prevents the hair from becomming dry and brittle? (A) sebum (B) cerumen (C) serum (D) keratin

____17. The tube leading from the urinary bladder to the outside is the (A) distal convoluted tubule (B) Henle's loop (C) ureter (D) (D) urethra.

____18. Conical projections within the cortex of the kidney are the (A) ureters (B) calyces (C) papillae (D) collecting tubules.

____19. New cells of the epidermis originate in the (A) dermis (B) stratum corneum (C) stratum germinativum (D) corium.

____20. Proximal convoluted tubule is to the loop of Henle as distal convoluted tubule is to (A) collecting tubule (B) Bowman's capsule (C) papilla (D) renal pelvis (E) none of these.

____21. The outermost layer of the epidermis is the (A) stratum corneum (B) stratum mucosum (C) stratum lucidum (D) stratum germinativum.

____22. The production of excess pigment in the skin is stimulated mainly by (A) vitamin D (B) infrared rays (C) melanocytes (D) ultraviolet rays.

____23. Adipose tissue in the skin is found mainly in the (A) epidermis (B) dermis (C) sebaceous glands (D) subdermal layer.

____24. The chief function of the kidneys is the excretion of products resulting from the decomposition of (A) starches (B) sugars (C) proteins (D) fats.

____25. Base of renal pyramid is to cortex as apex of renal pyramid is to (A) hilum (B) renal pelvis (C) renal medulla (D) renal artery (E) renal vein.

Section III. True or False.

____26. The kidneys are located near the dorsal surface of the abdominal cavity.

____27. Sweat is produced in uniform amounts over the body.

____28. Pigment cells are present in the stratum corneum of the skin.

____29. Regulation of body temperature is one function of the skin.

____30. In the kidney, the glomeruli are located within the medulla.

____31. The urine contains a higher percentage of urea than does the plasma.

____32. Feathers of birds and the hairs of mammals are alike in their manner of origin.

____33. The layers of the epidermis and the dermis' are held together securely by the barrier layer.

Unit Outline
Grades 11, 12
Physics R
Unit: Measurement and
Data Handling

Measurement is treated under the topic of "Motion" in the Mechanics, Energy, and Kinetic Theory unit.

Unit Outline
Grades 11, 12
Physics R
Unit: Mechanics, Energy,
and Kinetic Theory

I. Motion

- A. Analyzing motion through the use of graphs
    - 1. Velocity, displacement, and time relationships
    - 2. Acceleration
    - 3. Measurement of motion
        - a. Graphical analysis and determination of displacement, velocity, and acceleration relationships
        - b. Mathematical analysis of displacement, velocity, and acceleration relationships
        - c. Vectors and scalars
- B. Force and motion
    - 1. Inertia, mass, and weight relationships
    - 2. Force and acceleration -- Newton's Second Law
    - 3. Action-reaction -- Newton's Third Law
        - a. Momentum
        - b. Conservation of momentum
- C. Forces in equilibrium
    - 1. Concurrent forces
        - a. Applications of concurrent forces and equilibrium
        - b. Vector analysis of forces
    - 2. Parallel forces
        - a. Equilibrium and torque
        - b. Center of gravity
- D. Work and energy
    - 1. Work -- scientific definition (W=Fxs)
    - 2. Energy -- kinetic and potential
    - 3. Work and energy transfer
        - a. Simple machines and work
        - b. Conservation of energy
    - 4. Energy "crises"
        - a. Technology and energy usage
        - b. Conservation measures

II. Molecules in Motion

- A. Structure of matter
- B. States of matter -- properties of solids, liquids, and gases
- C. Molecules, heat, and temperature

III. Thermal Expansion and Thermal Measurement

- A. Temperature scales
    - 1. Kelvin, Celcius, and Fahrenheit scales
    - 2. Conversion from one scale to the other

- B. Linear and volumetric expansion
    - 1. Expansion of solids and the coefficient of linear expansion
    - 2. Expansion of liquids
- C. Heat energy
    - 1. Heat exchange and conservation of energy
        - a. Specific heat of solids
        - b. Change of state, heat of fusion, and vaporization

IV. Gas Laws and Heat Engines

- A. Effects of temperature changes on gases
    - 1. Changes in volume
    - 2. Changes in pressure
- B. Heat engines

Suggested Activities
Grades 11, 12
Physics R
Unit: Mechanics, Energy,
and Kinetic Theory

OBJECTIVE: To discover the concept that motion under the force of gravity is uniformly accelerated; to practice graphing scientific data and interpreting data; to apply measurement techniques

TITLE: "Accelerated Motion"

SOURCE: Stollberg/Hill. Physics Fundamentals and Frontiers. Houghton Mifflin, p. 15.

OBJECTIVE: To develop within the student an understanding of mass and weight and the differences between the two

TITLE: "Mass Weight Lab"

SOURCE: Stollberg/Hill. Physics Fundamentals and Frontiers. Houghton Mifflin, p. 43.

OBJECTIVE: To study Newton's Second Law -- the relationship of unbalanced force to acceleration

TITLE: "Force and Motion"

SOURCE: Stollberg/Hill. Physics Fundamentals and Frontiers. Houghton Mifflin, p. 51.

OBJECTIVE: To set up a situation with known forces to let the student discover the parallelogram rule for adding vectors. This lab is used as an introduction to vector addition.

TITLE: "Vector Lab -- The Addition of Concurrent Forces"

SOURCE: Stollberg/Hill. Physics Fundamentals and Frontiers. Houghton Mifflin, p. 77.

OBJECTIVE: To acquaint students with different simple machines; to have students calculate actual and ideal mechanical advantage and efficiency of the machines. The machines used in the lab are the inclined plane, jackscrew, pulley, wheel and axle, and lever.

TITLE: "Simple Machines Lab"

SOURCE: Teacher developed

OBJECTIVE: To observe and discuss the following concepts: Brownian movement, gas pressure, diffusion, cohesion, adhesion, surface tension, crystal structure, elasticity, and temperature effect. This is an introduction to the major concepts that will be covered in Unit II.

TITLE: "Molecules"

SOURCE: Stollberg/Hill. Physics Fundamentals and Frontiers. Houghton Mifflin, pp. 141-144.

OBJECTIVE: To understand the concept of specific heat capacity; to give the students first-hand experience with the calorimeter; to solve heat exchange problems

TITLE: "Specific Heat Capacity of a Metal"

SOURCE: Stollberg/Hill. Physics Fundamentals and Frontiers. Houghton Mifflin, pp. 199-203.

OBJECTIVE: To work with and understand heat exchange in melting and freezing

TITLE: "The Melting of Ice"

SOURCE: Stollberg/Hill. Physics Fundamentals and Frontiers. Houghton Mifflin, pp. 212-214.

Resources
Grades 11, 12
Physics R
Unit: Mechanics, Energy,
and Kinetic Theory

Text Materials

Hewitt, Paul. Conceptual Physics. Little, Brown and Company, 1974, pp. 8-81, 141-156, 210-237.

Stollberg/Hill. Physics -- Fundamentals and Frontiers. Houghton Mifflin, 1975, pp. 5-133, 141-243.

Films

Behavior of Gases, IU Film Rental

Energy, the American Experience, Modern Talking Pictures

Energy vs. Ecology, Modern Talking Pictures

Fluids in Weightlessness, NASA

Frames of Reference, Indiana University

Introduction to Physics, Indiana University

Mechanical Energy and Thermal Energy, IU Film Rental

People and Particles, ERDA Energy Film Catalogue

Random Events, Indiana University

Straight Line Kinematics, Indiana University

The Three E's: Energy, Ecology, and Economics, ERDA

Filmstrips -- High School Learning Center

Heat and Temperature

Molecules

Simple Machines

Exemplary Activity
Grades 11, 12
Physics R
Unit: Mechanics, Energy,
and Kinetic Theory

Reference:

Stollberg/Hill. "Specific Heat Capacity of a Metal," Physics -- Fundamentals and Frontiers. Houghton Mifflin, 1975, pp. 199-203.

Evaluation Sample
Grades 11, 12
Physics R
Unit: Mechanics, Energy,
and Kinetic Theory

Physics Test

____ 1. A moving car has (A) potential energy (B) kinetic energy (C) heat energy (D) no energy but only inertia.

____ 2. No kinetic energy is possessed by (A) a shooting star (B) a propeller on a plane during flight (C) a pendulum at the middle of its swing (D) an elevator standing at the fifth floor (E) a cyclone.

____ 3. Which of the following terms includes all of the others? (A) energy of composition (B) energy of position (C) energy of condition (D) potential energy (E) none are correct

____ 4. A vector quantity is by definition (A) a quantity having both direction and magnitude (B) a force (C) applicable only to a body that is in motion (D) a quantity having magnitude only.

____ 5. The metric prefix meaning 10^3 is (A) milli (B) kilo (C) deka (D) centi.

____ 6. The number of significant figures in the number 0.07004 is (A) 2 (B) 3 (C) 4 (D) 5.

____ 7. A gasoline tank holds 16.0 gallons. An equivalent volume is (A) 6.0 liters (B) 600. liters (C) 60.0 liters (D) 65.0 liters.

____ 8. A quantity having only magnitude is called (A) vector (B) displacement (C) force (D) scalar.

____ 9. When a person places a coin on a card and supports both on his/her finger, he/she may snap the card out from the coin without disturbing it. This illustrates the principle of (A) centrifugal force (B) inertia (C) accelerated motion (D) gravitation (E) action-reaction.

____10. The mass of an object (A) has no dependence upon external forces (B) depends on the distance from the center of the earth (C) varies with the force of gravity (D) is equal to the density of the object (E) is the scientific name for the weight of the object.

____11. Which of the following is true about a freely falling object? (A) The acceleration changes by 9.8 m/sec every second. (B) The object falls 9.8 meters during the first second. (C) The acceleration depends upon the weight of the object. (D) The average velocity during the first second is 4.9 m/sec.

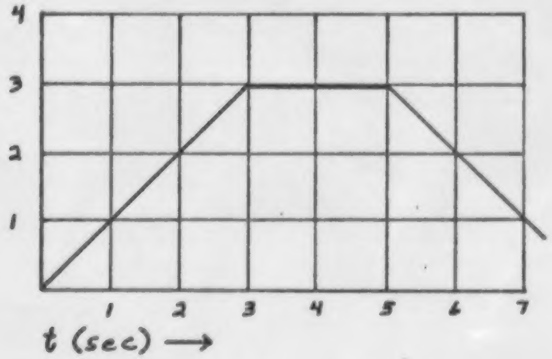
Evaluation Sample (Cont.)
Grades 11, 12
Physics R
Unit: Mechanics, Energy,
and Kinetic Theory

12-14. Refer to the graph below.

____12. If this is an acceleration vs time graph, what is the velocity at t=4 sec? (A) 6 m/sec (B) 12 m/sec (C) 3 m/sec (D) 7.5 m/sec

____13. What is the distance at t=6 sec if this is a velocity vs time graph? (A) 13 m (B) 15 m (C) 18 m (D) 2 m

____14. If this is a distance vs time graph, what is the average velocity from t=0 to t=5 sec? (A) 15 m/sec (B) 7 1/2 m/sec (C) 3/5 m/sec (D) 3 m/sec



____15. The change in distance per unit time without reference to direction is called (A) velocity (B) speed (C) inertia (D) acceleration (E) distance.

____16. Given:

Speed	Distance	Time
33 m/sec	1.0×10^2 m	?

What is the unknown quantity? (A) .30 sec (B) 3.0 sec (C) .58 min (D) 67 sec

____17. If a baseball is thrown straight upward, then at the top of its flight (A) its potential energy is equal to 1/2 of its kinetic energy (B) it possesses no energy (C) its potential energy will be at a minimum while its kinetic energy will be at a maximum (D) it will possess no potential energy and 1/2 of its kinetic energy (E) it will have no kinetic energy and it will have maximum potential energy.

____18. Moving downward in an elevator produces a semi-weightless feeling at the beginning. This means that (A) one has less mass (B) gravity is less (C) one's potential energy is increasing (D) none of these.

____19. A bullet shot from a gun held in a horizontal position (A) strikes the ground much later than one dropped vertically from the same point at the same instant (B) is stopped by air resistance alone (C) strikes the ground at approximately the same time as one dropped vertically from the same point at the same instant (D) travels in a straight path (E) strikes the ground much sooner than one dropped vertically from the same point at the same instant.

____20. A 10 lb. weight does not fall four times as fast as a 2 1/2 lb. weight because (A) the attractive force of the earth is the same on both (B) air friction is greater on the larger mass (C) the ratio of force to mass is the same for each (D) the density of the larger mass may be four times as great as the smaller so that each has the same volume (E) none of the preceding.

____21. If the velocity of a body increases, it is certain that during the time of this increase (A) the density of the body increases (B) the acceleration of the body increases (C) the body is accelerated (D) the acceleration of the body is constant.

____22. The inertia of a body tends to cause the body to (A) speed up (B) slow down (C) resist any change in its motion (D) fall to the surface of the earth.

____23. A certain force is capable of giving a 1000 lb object an acceleration of 10 ft/sec^2. This same force would accelerate a 500 lb object (A) 5 ft/sec^2 (B) 10 ft/sec^2 (C) 20 ft/sec^2 (D) 2 ft/sec^2 (E) none of these.

____24. Given a body starting from rest and moving with uniformly accelerating motion, (A) the acceleration produced will be equal to the change of distance per unit time (B) the force causing the uniform acceleration must continually increase, since the velocity is continually increasing (C) the acceleration produced by a constant force is directly proportional to the mass of the body (D) the acceleration produced is directly proportional to the force acting on the body, providing the mass of the body is not changed (E) the acceleration can never be greater than that of a freely falling body.

____25. The gravitational pull of the earth determines the (A) weight of a body (B) atomic energy of a body (C) density of a body (D) state of a body (E) mass of a body.

____26. If the diameter of the earth were twice its present value while the mass remained the same, the weight of an object on the earth's surface would be (A) twice its present value (B) one/half its present value (C) the same as its present value (D) one-fourth its present value (E) four times its present value.

____27. A measurement of 3.0 cm is to be added to a measurement of 5.52 cm, and the sum is then to be multiplied by 0.2 cm. The correct expression of the result in square cm is (use correct number of significant figures) (A) 1.7 (B) 2 (C) 1.70 (D) 1.704.

____28. When multiplying measurements expressed in scientific notation, the exponents are (A) added (B) multiplied (C) subtracted (D) divided (E) none of these.

____29. Which of the following is the same as 25.4 mm? (A) .00254 m (B) 254 cm (C) 1 inch (D) 1 ft (E) 12 ft

____30. The force in newtons required to give an object of mass 2.0 kg an acceleration of 6 m/sec^2 is (A) 0.33 (B) 18 (C) 3.0 (D) 12.

____31. A body of mass 1.0 kg has a weight near the earth's surface of about (A) 1.0 newton (B) 9.8 kilogramweights (C) 9.8 newtons (D) 1/9.8 kilogramweight.

____32. If the unbalanced force on a body is zero, it follows that the body has zero (A) velocity (B) energy (C) momentum (D) acceleration (E) all of the above are zero if the net force is zero.

____33. How much force is needed to accelerate a 440 kg cart at 5.0 m/sec^2? (A) 4.4 x 10^2 N (B) 2.2 x 10^3 N (C) 5.0 N (D) 3.3 x 10^3 N

____34. If a 1000 kg automobile is traveling at 60 m/s, the force needed to stop the automobile is (A) 1 x 10^2 (B) -2 x 10^{3}N (C) -.5 x 10^{3}N (D) +2 x 10^{2}N.

____35. A 200 lb skydiver reaches a terminal velocity of about 140 miles per hour. The air resistance he encounters at this time is _?_ lbs. (A) 140 (B) 200 (C) 60 (D) 340

Unit Outline
Grades 11, 12
Physics R
Unit: Waves and Wave
Phenomena

I. Reflection of Light

- A. Mirrors as reflectors
  - 1. Plane mirrors and image formation
    - a. Law of reflection
    - b. Formation of images
  - 2. Curved mirrors
    - a. Concave mirrors and convex mirrors
      - (1) Ray optics and image formation
      - (2) Real and virtual images
- B. Illumination

II. Refraction of Light

- A. Refraction -- definition
- B. Relationships -- angle of incidence, angle of refraction, Snell's Law ($N_1 \sin \angle_1 = N_2 \sin \angle_2$)
- C. Lenses
  - 1. Types -- convex and concave
    - a. Image formation
      - (1) Ray optics -- images by construction
      - (2) Relationships -- D_i, D_o, F -- lensmaker's formula
      - (3) Virtual and real images

III. Waves and Sound

- A. Wave characteristics
  - 1. Slinky
  - 2. Water waves -- ripple tank experiments
- B. Sound waves
  - 1. Characteristics and behavior
  - 2. Music and noise

IV. Wave Nature of Light

- A. Interference and diffraction of light
- B. Velocity, frequency, wavelength

V. Color

- A. Separation of light into colors
  - 1. Use of diffraction grating and prism
  - 2. Color and wavelength
- B. How the eye sees color
  - 1. Physiological and psychological effects
  - 2. Color combination -- addition and subtraction

Suggested Activities
Grades 11, 12
Physics R
Unit: Waves and Wave
Phenomena

OBJECTIVE: To introduce the law of reflection through the use of plane mirrors

TITLE: "Reflections From a Plane Mirror"

SOURCE: Stollberg/Hill text, p. 405.

OBJECTIVE: To introduce the concept of refraction and to use Snell's Law

TITLE: "The Refraction of Light"

SOURCE: Stollberg/Hill text, p. 428.

OBJECTIVE: To determine the focal point of a spherical lens through investigation and calculations

TITLE: "Spherical Lens"

SOURCE: Stollberg/Hill text, p. 441.

OBJECTIVE: To measure the speed of sound using a resonance tube

TITLE: "The Speed of Sound"

SOURCE: Teacher lab -- source unknown

OBJECTIVE: To observe diffraction patterns formed by light as it passes through single and double slits and diffraction gratings using various light sources

TITLE: "Interference and Diffraction"

SOURCE: Stollberg/Hill, p. 496.

OBJECTIVE: To acquaint the students with the concept of polarization and the function of polarizing filters

TITLE: "Polarization"

SOURCE: Stollberg/Hill, pp. 503-505, and teacher materials

OBJECTIVE: To study interference patterns commonly called Newton's Rings

TITLE: "Newton's Rings"

SOURCE: Stollberg/Hill, p. 505, and teacher materials

OBJECTIVE: To compare patterns on the oscilloscope produced by your voice and a tuning fork; to acquaint the students with the use of the oscilloscope and to see how it can show variations in tone quality

TITLE: "Oscilloscope"

SOURCE: Stollberg/Hill, p. 632, and teacher materials

Resources
Grades 11, 12
Physics R
Unit: Waves and Wave Phenomena

Text Materials

Hewitt, Paul. Conceptual Physics. Little, Brown, and Co., 1974, pp. 400-437.

Stollberg/Hill. Physics -- Fundamentals and Frontiers. Houghton Mifflin, 1975, pp. 405-544.

Films

Introduction to Optics, PSSC -- Indiana University Film Rental

Laser Light -- Indiana University Film Rental

Simple Waves, PSSC -- rental film

Speed of Light in Air and Water, PSSC -- Indiana University Film Rental

Transparencies

Light Transparencies, Popular Science Series, Robert J. Brady Co.

Physical Science. Printed originals from 3M Visual Products Division.

Records

The Science of Sound. Bell Telephone Labs.

Exemplary Activity
Grades 11, 12
Physics R
Unit: Waves and Wave
Phenomena

Reference:

Stollberg/Hill. "Spherical Lens," Physics -- Fundamentals and Frontiers. Houghton Mifflin, 1975, p. 441.

Evaluation Sample
Grades 11, 12
Physics R
Unit: Waves and Wave
Phenomena

Multiple choice -- 3 points each.

____ 1. A 100. kg mass on the surface of the earth has a weight of (A) 0.22 lb (B) 98.0 nt (C) 980. nt (D) 0.980 nt.

____ 2. The product of the mass and velocity of a body is called (A) kinetic energy (B) acceleration (C) angular velocity (D) momentum (E) none of these.

____ 3. The use of a certain machine makes it possible to overcome a resistance of 75 lb by exerting 15 lb of force. The (A) IMA is 5.0 (B) AMA is .20 (C) AMA is 5.0 (D) IMA is 0.20.

____ 4. Work is the product of force and (A) velocity (B) mass (C) distance (D) time.

____ 5. If 100. g of a metal (specific heat, 0.20 cal/g °C) at 200.0 °C is dropped into 200. g of water at 0.0°C, the final temperature of the mixture, assuming no heat loss to the surroundings, is (A) 15.3°C (B) 16.0°C (C) 18.2°C (D) 22.6°C.

____ 6. A 1000-watt electric iron is used for 30.0 hours at 5¢ per kwh. The cost of operation is (A) $1.67 (B) $1.50 (C) $0.15 (D) $0.015.

____ 7. A device used to protect an electric circuit against an overload is a/an (A) coulombmeter (B) electrolytic cell (C) wire of high melting point (D) fuse.

____ 8. The joule per second is called the (A) coulomb (B) watt (C) faraday (D) ampere.

____ 9. When connecting a voltmeter and an ammeter in an electric circuit, you should (A) connect both instruments in series (B) connect both instruments in parallel (C) connect the voltmeter in parallel and the ammeter in series (D) connect the voltmeter in series and the ammeter in parallel.

____10. If a lamp is connected in an electric circuit, the electric energy in the circuit is converted to (A) magnetism (B) mechanical motion (C) chemical reaction (D) heat and light.

____11. The volt is defined in terms of (A) joules (B) coulombs (C) newtons (D) joules per coulomb.

____12. Which term is not related to the others? (A) vector (B) resultant (C) component (D) exponent (E) equilibrant

____13. Sound waves are (A) transverse (B) elliptical (C) spiral (D) longitudinal.

____14. The shortening of the length of the air column in a wind instrument (A) raises the pitch (B) lowers the intensity (C) lowers the quality (D) raises the quality.

____15. A convex MIRROR produces (A) real images (B) inverted images (C) both real and virtual images (D) virtual images.

____16. An object is placed 96 cm from a concave mirror having a focal length of 32 cm. The image distance from the mirror is (A) 24 cm (B) 48 cm (C) 60 cm (D) 72 cm.

____17. An object is placed 5.0 ft in front of a CONVEX mirror having a radius of curvature of 5.0 ft. The image distance from the mirror is (A) 10 in (B) 15 in (C) 18 in (D) 20 in.

____18. An object is placed 30.0 cm from a lens forming an enlarged virtual image 75.0 cm from the lens and on the same side as the object. The focal length of the lens is (A) 65.0 cm (B) 50.0 cm (C) 21.3 cm (D) 15.0 cm.

____19. If an object is placed beyond a distance of 2F from a converging lens, the image produced will be (A) virtual and enlarged (B) virtual and reduced (C) real and enlarged (D) real and reduced.

____20. A camera forms images that are (A) virtual (B) erect (C) enlarged (D) real.

____21. The color of light depends on its (A) frequency (B) amplitude (C) intensity (D) direction.

____22. The phenomenon of polarization demonstrates that light (A) consists of many wavelengths (B) is high frequency vibrations (C) is composed of quanta (D) is propagated transverse waves.

____23. Of the following, all are luminous bodies except (A) the moon (B) an incandescent lamp (C) a fluorescent lamp (D) the sun.

____24. A "C" note on a violin and a "C" note on a trumpet have a different quality to the ear because they differ in (A) the amplitude of the sound wave (B) the number of overtones present (C) the frequency of vibration (D) the velocity of the sound wave (E) the pitch.

____25. The period of vibration of a stretched cord is nearly INDEPENDENT of (A) its length (B) its mass per unit length (C) moderate changes in amplitude of vibration (D) the tension in the cord (E) its diameter.

____26. In general, the energy carried by a sound wave increases with the (A) wave length (B) phase (C) harmonic beat (D) amplitude (E) period.

____27. A wave has a frequency of 20 and a wavelength of 3 ft. The velocity is (A) 60 ft/sec (B) 6.67 ft/sec (C) 0.15 ft/sec (D) 20 ft/sec (E) none of these.

____28. A sound may travel faster in a given medium if (A) the frequency of vibration of the source is reduced (B) overtones are present (C) the pitch is raised (D) the amplitude of the sound is increased (E) the temperature of the medium is increased.

Use the following words for 29 through 32:
(A) reflection (B) refraction (C) interference (D) diffraction (E) Doppler effect

____29. Reverberation is an example of multiple ____ of sound.

____30. A passenger in an airplane does not hear the same pitch of the engine as the friend he leaves behind at the airport because of ____.

____31. Beats are due to ____.

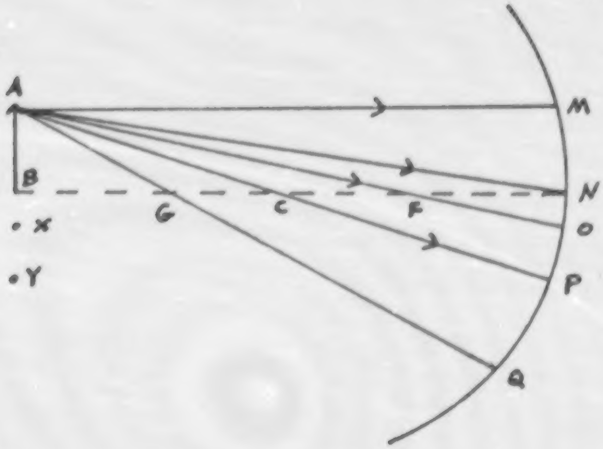
____32. When a wave passes through a narrow opening, ____ takes place.

____33. You are standing beside a highway. A car sounding its horn approaches and passes you at a steady speed. You hear (A) a constant pitch as the car approaches and then suddenly a constant lower pitch as it goes away (B) a constant pitch as the car approaches, then suddenly a constant higher pitch as it goes away (C) a pitch that starts high and steadily decreases (D) a pitch that starts low and steadily increases.

____34. A guitar string and a pitch pipe produce 2 beats per second when sounded together. When the string is loosened, the beats disappear. If the pitch pipe frequency is 440 Hz, the original frequency of the guitar string was (A) 220 Hz (B) 438 Hz (C) 442 Hz (D) 880 Hz.

____35. In the graph of a sound wave on an oscilloscope screen, (A) amplitude is related to the pitch of the sound, and shape to its quality (B) wavelength is related to the quality of the sound, and shape to its amplitude (C) wavelength is related to pitch, and amplitude to quality (D) shape is related to quality, and wavelength to pitch.

Evaluation Sample (Cont.)
Grades 11, 12
Physics R
Unit: Waves and Wave
Phenomena



The curved line in the figure at the left represents a section through a concave mirror. AB is an object, C is the center of curvature, and F is the focal point of the mirror. The lines represent rays leaving the object.

NO = BX
NG = 3NF
AB = BY
BC = CN

AM is parallel to BN, the axis of the mirror.

Choose one of the following (by letter) to complete questions 1-5.

(X) point X; (Y) point Y; (C) point C; (F) point F; (G) point G; (R) none of these

____ 1. The ray AM is reflected back through __.

____ 2. The ray AP is reflected back through __.

____ 3. The ray AN is reflected back through __.

____ 4. The ray AQ is reflected back through __.

____ 5. The ray AO is reflected back through __.

Choose by letter from A-M from the group below to answer questions 6-10.

(A) finite left of B (B) at B (C) between B and G (D) at G
(E) between G and C (F) at C (G) between C and F (H) at F
(I) between F and N (K) at N (L) finite right of N (M) at infinity or no image is formed

____ 6. The image of an object placed at C will be __.

____ 7. The image of an object placed at F will be __.

____ 8. The image of an object placed at HALFWAY BETWEEN F AND N will be __.

____ 9. The image of an object placed at G will be __.

____10. The image of an object placed at B will be __.

____11. The image formed by a plane mirror is always (1) virtual, (2) real, (3) as far behind the mirror as the object is in front of it, (4) the same size as the object. Which of the four descriptions listed are true? (A) 1 and 3 (B) 2 and 4 (C) 1, 3, and 4 (D) 2, 3, and 4

____12. The shortest plane mirror in which you can see all of yourself is what fraction of your height? (A) all of it (B) half of it (C) one-third of it (D) between one-half and all of it

____13. A concave spherical mirror has a radius of 10 cm. A parallel beam of light that strikes the mirror (A) is reflected to a focus 10 cm from the mirror (B) is reflected to a focus 5 cm from the mirror (C) is reflected to a focus 20 cm from the mirror (D) does not come to a focus at all.

____14. A virtual image (A) can be projected on a screen (B) is located at the point from which rays of light seem to diverge (C) is always larger than the object (D) is always upside down.

____15. When light is reflected, the angle of incidence equals the angle of reflection (A) for plane mirrors, but not for spherical ones or for rough surfaces (B) for plane and spherical mirrors, but not for rough surfaces (C) for plane mirrors and rough surfaces, but not for spherical mirrors (D) in all three of these cases.

____16. Parallel light reflected from a convex mirror (A) can be brought to a focus (B) diverges (C) sometimes diverges and sometimes converges (D) sometimes diverges, sometimes converges, and sometimes is parallel.

____17. Spherical aberration is minimized by (A) using only the narrow central part of a spherical mirror (B) using as much of the spherical mirror as possible (C) a combination of two or more mirrors (D) bending in the outer edges of a spherical mirror.

____18. Which of the following is one of the SI base units? (A) candela (B) lumen (C) lux (D) watt

____19. A lumen is a measure of (A) energy (B) force (C) power (D) pressure.

____20. What is the illumination in lux provided by a 1000 cd lamp at a distance of 2.0 m? (A) 250 (B) 500 (C) 2000 (D) 4000

____21. A certain lamp provides an illumination of 600 lx at a distance of 1.0 m from the lamp. At a distance of 3.0 m, the illumination is ____ lx. (A) 67 (B) 2.0×10^2 (C) 6.0×10^2 (D) 1.8×10^3

____22. What is the efficiency of a 20-W fluorescent lamp that produces 1000 lumens of light? The mechanical equivalent of light is 680 lumens per watt. (A) 2.0% (B) 7.4% (C) 34% (D) 68%

____23. The illumination on a book can be increased without changing the lights in a room by (A) using light-colored paint on the walls (B) wearing light-colored clothes (C) getting closer to the light (D) all of these.

Unit Outline
Grades 11, 12
Physics R
Unit: Electricity and
Magnetism

I. Electric Charges, Fields, and Current

- A. The electrical nature of matter
  - 1. Static electricity
    - a. Detection of charges
    - b. Determination of different charges and use of the electroscope
  - 2. Electric fields
    - a. Electric fields -- types
    - b. Electric field interactions -- use of Van de Graff generator to show field interactions
    - c. Electric fields and electric potential energy
  - 3. Electric circuits
    - a. Movement of charge and electric current
    - b. Electron path and complete circuit

II. Magnets and Magnetic Fields

- A. Magnetic behavior
- B. Magnetic fields
  - 1. Magnetic field of a permanent magnet
  - 2. Magnetic field of moving charges
  - 3. Magnetic field interactions
  - 4. Electromagnetism -- electromagnetic interactions

III. Direct Current and Alternating Current

- A. Electric energy, sources, and loads
- B. Current, voltage, resistance
  - 1. Ohm's Law
  - 2. Electric resistance
    - a. Causes of -- in conductors
    - b. Resistor circuits (series and parallel)
- C. Power and energy in electric circuits
  - 1. Measurement of power
  - 2. Power, energy, and cost of electricity
  - 3. Conservation of energy and use of electricity

IV. Electromagnetic Interactions

- A. Electromagnetic induction
  - 1. Electric meters
  - 2. Motors and generators
    - a. Principles
    - b. Operation
  - 3. Transformers
    - a. Step up and step down transformers
    - b. Energy conservation in transformers -- power input and power output

Suggested Activities
Grades 11, 12
Physics R
Unit: Electricity and
Magnetism

OBJECTIVE: To enable the students to observe the behavior of charged objects and to acquaint themselves with the nature of electric charges and with electric attraction and repulsion

TITLE: "Electric Charges"

SOURCE: Stollberg/Hill text, p. 251.

OBJECTIVE: To familiarize the students with the function and operation of the electroscope and to develop the concept of induction

TITLE: "The Electroscope"

SOURCE: Stollberg/Hill text, p. 260.

OBJECTIVE: To enable the students to find out in the laboratory just what the effects of an electric current in a magnetic field are; this precedes the discussion of electromagnetism in the textbook

TITLE: "The Magnetic Effects of an Electric Current"

SOURCE: Stollberg/Hill text, p. 301.

OBJECTIVE: To familiarize students with the shape of a magnetic field around various types of magnets and to enable them to study the interaction of two or more magnetic fields

TITLE: "The Magnetic Field of a Bar Magnet"

SOURCE: Teacher-made materials

OBJECTIVE: To determine how much energy an electrical appliance uses and to find the cost of operating this appliance for a period of time

TITLE: "Electric Power, Energy, and Cost"

SOURCE: Unknown

OBJECTIVE: To determine the electric equivalent of heat and to gain experience in setting up series and parallel circuits and reading meters

TITLE: "Electric Equivalent of Heat"

SOURCE: Teacher lab, source unknown

OBJECTIVE: To learn to read the electric voltmeter and ammeter

TITLE: "How to Read the Electric Voltmeter and Ammeter"

SOURCE: Teacher-developed programmed learning sequence

OBJECTIVE: To determine the internal resistance of cells in series and parallel and to gain experience in using Ohm's Law

TITLE: "Internal Resistance of Cells in Series and Parallel"

SOURCE: Teacher developed

OBJECTIVE: To use teacher-made resistance boards to gain experience connecting resistances in series and parallel and measuring total resistance, then checking it with calculations

TITLE: "Resistor Lab"

SOURCE: Teacher-made materials

Resources
Grades 11, 12
Physics R
Unit: Electricity and
Magnetism

Text Materials

Hewitt, Paul. Conceptual Physics. Little, Brown and Company, 1974, pp. 329-360.

Stollberg/Hill. Physics -- Fundamentals and Frontiers. Houghton Mifflin, 1975, pp. 251-398.

Films

A Magnet Lab, PSSC -- Indiana University Rental

The Triode -- Indiana University Rental

When the Circuit Breaks -- Modern Talking Picture Service

Transparencies

Current-Electricity Series -- physics lab file

Magnetic Effects Series -- physics lab file

Opaque Material

Photographs of iron filings in magnetic fields -- student project in instructor file

Exemplary Activity
Grades 11, 12
Physics R
Unit: Electricity and
Magnetism

Reference:

"How to Read the Electric Voltmeter and Ammeter," teacher-developed programmed learning sequence, available in high school physics lab, Room 132.

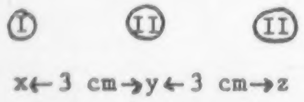
Evaluation Sample
Grades 11, 12
Physics R
Unit: Electricity and
Magnetism

Part I. Multiple Choice

____ 1. A negatively charged rubber rod is brought near a positively charged electroscope. The result is that (A) the leaves of the electroscope will move farther apart (B) the rod will lose its charge to the electroscope (C) nothing will happen that can be detected without electrical instruments (D) some of the positive charge on the leaves will be neutralized.

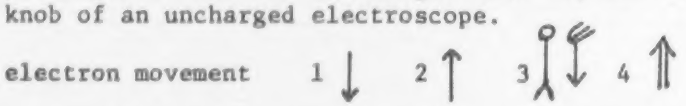
____ 2. A negative charge on a rubber rod would most likely be caused by (A) the rod losing protons (B) the rod gaining protons (C) the rod gaining electrons (D) the rod losing electrons (E) none of these.

____ 3. Refer to the following diagram.



Bodies I and II when in position x and y are given equal like charges of electricity. Body II is now moved to position z. The force between the bodies will now be (A) unchanged (B) one-fourth as great (C) one-half as great (D) twice as great.

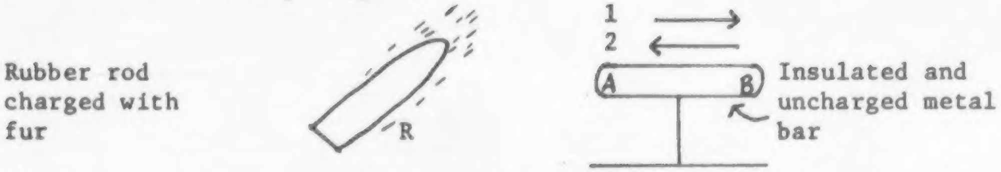
____ 4. A negatively charged rubber rod is brought near to, but does not touch, the knob of an uncharged electroscope.



(A) There is no effect on the leaves of the electroscope. (B) The leaves diverge with a positive charge resulting from electron motion shown as #2. (C) The leaves diverge with negative charge resulting from motion #1. (D) The leaves diverge with a positive charge from motion shown as #3. (E) None of these

____ 5. If the above electroscope were grounded while the rod was near and then the ground and the rod were removed in that order, what would happen when the rod was brought near the electroscope again? (A) The leaves would move apart because the scope had a positive charge. (B) The leaves would move apart because the electroscope had a negative charge. (C) The scope has no charge on it but the leaves will separate because of the induced charge. (D) The leaves will converge because of the positive charge on the scope. (E) The leaves will converge because of the negative charge on the scope.

6-8. Refer to the following diagram.


Rubber rod charged with fur
R
1
2
A
B
Insulated and uncharged metal bar

____ 6. As a result of the presence of the rod near the bar, (A) negative charges move in direction 1 (B) negative charges move in direction 2 (C) positive charges move in direction 1 (D) positive charges move in direction 2.

____ 7. As a result of the presence of the rod near the bar, the bar is (A) - at end A and - at end B (B) - at end A and + at end B (C) + at end A and - at end B (D) + at end A and + at end B.

____ 8. As a result of the presence of the rod slightly off to the side of the bar, the bar is (A) attracted and turns toward the rod R (B) repelled and turns away from rod R (C) not affected.

____ 9. A charged body is held near a negatively charged electroscope. The leaves of the electroscope diverge farther. The charged body is (A) negative (B) positive (C) either positive or negative (D) neither negative nor positive.

____10. The fundamental particle found in the atom that may be readily transferred from one point to another is called a (an) (A) ion (B) electron (C) proton (D) neutron.

____11. A device used to store an electric charge is a (an) (A) electroscope (B) Leyden jar (C) proof plane (D) lightning rod.

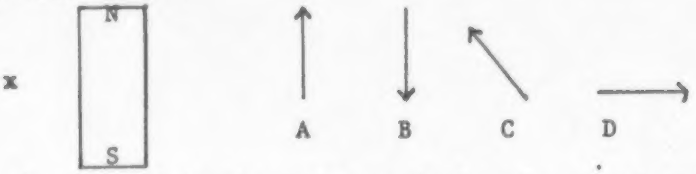
____12. Increasing the distance between the plates of a capacitor ____ its capacitance. (A) increases (B) decreases (C) has no effect on

____13. The energy acquired by an object having a 5.0 C charge moving through a 10.V potential difference is (A) .25 J (B) 50 J (C) 0.5 J (D) 2.0 J.

____14. The difference between atomic number and atomic weight indicates the number of ____ in an atom. (A) protons (B) electrons (C) neutrons (D) positrons

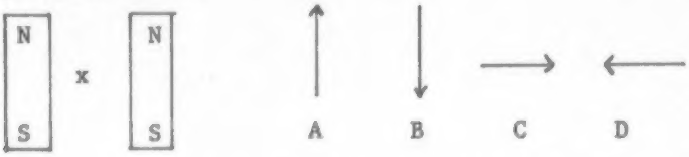
Evaluation Sample (Cont.)
Grades 11, 12
Physics R
Unit: Electricity and
Magnetism

____15. The direction of the magnetic field at the point marked is best shown by which arrow?



____16. A plastic rod is charged negatively at one end and positively at the other. The rod is (A) a magnet with its north pole at the positive end (B) a magnet with its north pole at its negative end (C) a magnet, but more information is needed to determine its polarity (D) not a magnet.

____17. The direction of the magnetic field at the point marked is best shown by which arrow?



____18. If a magnet is brought near a suspended bar magnet, (A) the two N poles attract each other (B) the N poles attract the S poles (C) the S poles attract each other (D) the N poles repel the S poles.

____19. Which statement is correct? (A) A magnetic pole is a point at the end of a magnet. (B) Magnetic poles are regions of strong magnetism on each end of a magnet. (C) When a bar magnet is broken into two pieces, the magnet is demagnetized. (D) The central part of a bar magnet is nonmagnetic.

____20. When a permanent magnet attracts an unmagnetized nail, which of the following does NOT happen? (A) The domains in the unmagnetized nail become lined up. (B) The nail becomes a temporary magnet with an N pole at one end and an S pole at the other end. (C) The nail is magnetized by induction. (D) When the nail is removed from the magnet, the nail immediately loses all magnetism.

____21. If the magnetic domains in a bar of iron are randomly oriented, the iron bar (A) will be strongly magnetized (B) will have a very weak or nonexistent field (C) will be repelled by a permanent magnet (D) will line up in a north-south direction when supported by a string.

Unit Outline
Grades 11, 12
Physics R
Unit: Energy, the Environment, and Our Economy

Refer to Physics S

Unit Outline
Grades 11, 12
Physics S
Unit: Measurement and
Data Handling

I. Units of Measurement

- A. Physical units, unit systems and dimensional analysis, conversion
- B. Length
- C. Mass
- D. Time
- E. Density
- F. Force

II. Data Handling, Analysis, and Problem Solving

- A. Math review
    - 1. General algebra and math review
    - 2. Factor label system
    - 3. Exponential notation and exponents
    - 4. Significant figures
    - 5. Introduction to vector trig
- B. Data handling and analysis
    - 1. Evaluating quality of data and data sources
    - 2. Data treatment, tests of significance
    - 3. Examining conclusions based on data with the inquiry process
    - 4. Using and organizing data to aid in forming logical conclusions
    - 5. Error evaluation and analysis
    - 6. Laboratory writeup procedures

Suggested Activities
Grades 11, 12
Physics S
Unit: Measurement and
Data Handling

The primary purpose of the physics laboratory is to develop problem-solving skills and provide students with hands-on experience in a variety of real problem solving. Individual project work is encouraged and emphasized. Students are given freedom to select a problem from a variety of sources. Students are required to plan a procedure, organize needed equipment, work with engineering situations related to their problem, and obtain and interpret data relative to the question posed in the problem. A comprehensive written report is required of one major project each grading period.

Laboratory work does not necessarily supplement current classroom topics, although in many cases student choice of problems causes it to do so. An attempt is made to allow students to discover in their laboratory work how scientists define a problem and the procedures they use to obtain an answer to that problem.

Approximately one-fifth of the classroom time is used in laboratory work. Many students utilize study hall time and after-school hours to supplement their laboratory work.

OBJECTIVE: To make measurements of length with a meter stick, a vernier caliper, and a micrometer caliper, and to realize the relationship between the construction of the instrument and the precision of the measurements

TITLE: "Measuring Length"

SOURCE: Williams, Trinklein, et al. Laboratory Experiments in Physics, pp. 1-5.

OBJECTIVE: To make measurements of mass with a platform balance and an inertial balance; to realize the difference between mass and weight

TITLE: "Measuring Mass"

SOURCE: Williams, Trinklein, et al. Laboratory Experiments in Physics, pp. 5-7.

OBJECTIVE: To make measurements of short time intervals and to identify sources of error in measurement procedures

TITLE: "Measuring Time"

SOURCE: Williams, Trinklein, et al. Laboratory Experiments in Physics, pp. 7-9.

OBJECTIVE: To measure the mass of objects in grams and the volume of objects in cubic centimeters, to use two methods to determine volume, and to determine the densities of several substances

TITLE: "Measurement of Mass and Density"

SOURCE: Unknown

Resources
Grades 11, 12
Physics S
Unit: Measurement and
Data Handling

Text Materials

Williams, John E.; Trinklein, Frederick E.; and Metcalfe, H. Clark. *Modern Physics*. Holt, Rinehart, and Winston, 1976, pp. 1-42, 653-686.

Williams, John E.; Trinklein, Frederick E.; Metcalfe, H. Clark; and Lefler, Ralph W. *Laboratory Experiments in Physics*. Holt, Rinehart, and Winston, 1972.

Films

Introduction to Physics

People and Particles

Random Events

Transparencies -- Physics lab file

Energy Use and Production

Exemplary Activity
Grades 11, 12
Physics S
Unit: Measurement and
Data Handling

OBJECTIVE: To measure the mass of objects in grams and the volumes of objects in cubic centimeters; to use two methods to determine volume; to determine the densities of several substances

MATERIALS AND EQUIPMENT: Metric ruler, box of steel paper clips, graduated cylinder, centigram balance, solid sphere, micrometer, vernier

PROCEDURE:

I. Density of a paper clip

A. Mass of one paper clip

1. Inspect your centigram balance and make sure that it is on zero.

2. Place one paper clip on the balance and measure its mass to the nearest hundredth of a gram. Repeat this procedure twice, using a different paper clip from the same box each time. Record your values for the mass of each of the three paper clips in Table 2-1. Record the average of your three measurements in Table 2-1 (watch significant figures).

3. Now place 10 paper clips on the balance and measure their total mass. Calculate the average mass of one paper clip. Record this value in Table 2-2.

4. Repeat Step 3, increase the number of clips on the balance by groups of 10 until you have a total of 50 clips on the balance. Record in Table 2-2.

B. Volume of a paper clip

Water Displacement Method

1. Tie as many paper clips to a piece of string as will fit easily into the graduated cylinder half full of water. Read the water level to the nearest tenth of a cubic centimeter. Lower the clips into the water until they are completely immersed. Dislodge any air bubbles that remain attached to the paper clips by gently shaking the string. Read the new volume indicated by the water level in the cylinder. Determine the total volume of the clips tied to the string.

2. From the total volume of the clips and the total number of clips tied to the string, calculate the volume of a single paper clip. Record in Table 2-3, Sect. B.

3. Use the average mass of a single clip as determined in Table 2-2 (for 50 clips) as the mass of the clip. Calculate the density of one paper clip and record this value in Table 2-3, Sect. C.

Measurement and Formula Method

1. Determine the linear measurements of the paper clip. Stretch a single clip out and determine its length and diameter (use a micrometer for the diameter). Calculate the volume by formula. Record in Table 2-3, Sect. D.
2. Use the same average mass as above and calculate and record the density of the paper clip in Table 2-3, Sect. E.

II. Given density

1. Look up density of steel in chemistry-physics handbook and record in Table 2-3, Sect. F.

TABLES

2-1 MASS OF ONE PAPER CLIP

Trial	Mass (g)
1	
2	
3	
Average	

2-2 AVERAGE MASS OF PAPER CLIPS

# of clips	Total mass (g)	Average mass of one clip
10		
20		
30		
40		
50		

2-3 DENSITY OF SOLIDS

	A	B	C	D	E	F	G
Material	Mass (g)	Vol.	Density	Volume	Density	Given Value	% Error
paper clip							

INTERPRETATIONS

1. How well does your average of the measurements of the mass of individual clips (Table 2-1) compare with the average mass of the clips shown on Table 2-2? Which measurement do you think most closely approximates the mass of a paper clip? Why?

2. Graph the data in Table 2-2. Plot the number of clips on the horizontal axis (abscissa) and the total mass of the clips on the vertical axis (ordinate).

3. Using your graph, predict the mass of 25, 35, and 70 paper clips. Verify your predictions by actual measurements. (Do in lab)

4. A full box of paper clips is supposed to contain 100 clips. Remove the clips from the box and put all of the clips on the balance. Measure their mass. Using your average value for a single clip, determine the number of clips that were in the box. Check your answer by actually counting the clips. (Do in lab)

5. How does your calculation of density using the water displacement method compare to the calculation using formula? Which method is closest to the value found in the handbook?

6. Find the percent error for the determination of density for the paper clip. Record in Table 2-3, Sect. G.

CALCULATIONS (DENSITY)

Paper Clip

1. Length = ____________________ Diameter = ____________________

2. Formula used for volume _______________ Calculation of volume __________

3. Calculation of density ________________________________

4. Percent error (calc.) (A) Water Displacement Method
   (B) Formula Method

Evaluation Sample
Grades 11, 12
Physics S
Unit: Measurement and
Data Handling

Reference:

Williams, John E.; Trinklein, Frederick E.; and Metcalfe, H. Clark. *Tests in Physics, Modern Physics*. Holt, Rinehart, and Winston, 1976, Chapters 1 and 2.

Unit Outline
Grades 11, 12
Physics S
Unit: Mechanics, Energy,
and Kinetic Theory

I. Vectors and Scalar Quantities
    A. Directionless quantities -- scalars
    B. Vector analysis and resolution
        1. Displacement, velocity, and acceleration
        2. Force
            a. Friction
            b. Gravity
            c. Torque
            d. Other
        3. Momentum
    C. Kinematics (motion)
    D. Dynamics
        1. Newton's Laws
        2. Collisions -- conservation of momentum and kinetic energy
        3. Corvilinear motion
        4. Simple harmonic and other motion
    E. Work, conservation of energy, and simple machines
        1. Mechanical advantage and efficiency
        2. Machine applications
    F. Kinetic theory
        1. Thermal effects
        2. Change of state -- calorimetry
        3. Properties of fluids
        4. Gas laws
        5. Laws of thermodynamics -- applications

The primary purpose of the physics laboratory is to develop problem-solving skills and provide students with hands-on experience in a variety of real problem solving. Individual project work is encouraged and emphasized. Students are given freedom to select a problem from a variety of sources. Students are required to plan a procedure, organize needed equipment, work with engineering situations related to their problem, and obtain and interpret data relative to the question posed in the problem. A comprehensive written report is required of one major project each grading period.

Laboratory work does not necessarily supplement current classroom topics, although in many cases student choice of problems causes it to do so. An attempt is made to allow students to discover in their laboratory work how scientists define a problem and the procedures they use to obtain an answer to that problem.

Approximately one-fifth of the classroom time is used in laboratory work. Many students utilize study hall time and after-school hours to supplement their laboratory work.

OBJECTIVE: To design, run, and evaluate an experiment of the student's own design, using a problem from Mechanics, Energy, and Kinetic Theory

TITLE: "A Problem Related to Mechanics, Energy, and Kinetic Theory"

SOURCE: Teacher developed

Each student is required a minimum of a minor lab in kinematics, vectors, and energy, with a major investigation in an area of his/her choosing.

Below are listed a few examples of past projects.

OBJECTIVE: To illustrate that energy is conserved in the normal swing of a pendulum; to sharpen kinematic skills

TITLE: "Energy Conservation in a Pendulum"

SOURCE: Modified by student and teacher from the PSSC Laboratory Manual

OBJECTIVE: To reinforce the concept of conservation of energy through work input, output, and losses in various simple machines

TITLE: "Efficiency of Simple Machines"

SOURCE: Teacher-student developed

OBJECTIVE: To reinforce kinematic and momentum concepts using tape timers and spring plunger carts

TITLE: "Conservation of Momentum"

SOURCE: Modified from Laboratory Experiments in Physics. Holt, Rinehart, and Winston, 1972.

Resources
Grades 11, 12
Physics S
Unit: Mechanics, Energy,
and Kinetic Theory

Text Materials

Jackson, Jim L. Proceeding National Energy Forum, Volumes I and II. University of Akron, 1976.

Physical Science Study Committee. Physics. D.C. Heath and Co., 1965, pp. 54-81.

Williams, Trinklein, and Metcalfe. Modern Physics. Holt, Rinehart, and Winston, 1976, pp. 43-222.

Films

Frames of Reference, PSSC Film -- Rental

Straight Line Kinematics, PSSC Film -- Rental

Three E's, Energy, Economics, and Environment, Modern Talking Picture Service -- Free loan

Filmstrips

Uniform and Accelerated Motion, Prentice-Hall Media -- High School Learning Center

Transparencies

Energy transparencies -- Personal file

Kinematics transparencies -- Personal file

Simple machines transparencies -- Personal file

Exemplary Activity
Grades 11, 12
Physics S
Unit: Mechanics, Energy,
and Kinetic Theory

Reference:

Williams, Trinklein, Metcalfe, and Lefler. "Conservation of Momentum," Laboratory Experiments in Physics. Holt, Rinehart, and Winston, 1972.

Evaluation Sample
Grades 11, 12
Physics S
Unit: Mechanics, Energy,
and Kinetic Theory

Reference:

Williams, John E.; Trinklein, Frederick E.; and Metcalfe, H. Clark. Tests in Physics, Modern Physics. Holt, Rinehart, and Winston, 1976, Chapters 3, 4, 5, 6, 7, 8, 9.

Unit Outline
Grades 11, 12
Physics S
Unit: Waves and Wave
Phenomena

I. Wave Characteristics

- A. Transverse vs. longitudinal
- B. Energy
- C. Factors affecting velocity, frequency, and amplitude
- D. Wave interaction
    - 1. Propagation
    - 2. Reflection
    - 3. Refraction
    - 4. Diffraction
    - 5. Interference and standing waves
    - 6. Impedance

II. Sound Waves

- A. General wave characteristics
- B. Sonic spectrum
- C. Quality
- D. Resonance -- strings and pipes
- E. Interference and beats

III. Light

- A. Wave nature
    - 1. Electromagnetic theory -- transverse nature of waves
    - 2. Particle effects and corpuscular theory
        - a. Photoelectric effect
        - b. Partial refraction
    - 3. Wave properties
        - a. Refraction
        - b. Diffraction
        - c. Interference
        - d. Polarization
- B. Illumination -- geometric effects
- C. Optics
    - 1. Image formation
    - 2. Mirrors and reflection
    - 3. Optical refraction
        - a. Change of velocity of light
        - b. Snell's Law
        - c. Critical angle refraction
    - 4. Lens optics
        - a. Converging lenses
        - b. Diverging lenses
        - c. Optical devices
        - d. Aberrations

D. Dispersion
  1. Refractive dispersion
  2. Dispersion by interference
  3. Spectral analysis

Suggested Activities
Grades 11, 12
Physics S
Unit: Waves and Wave
Phenomena

The primary purpose of the physics laboratory is to develop problem-solving skills and provide students with hands-on experience in a variety of real problem solving. Individual project work is encouraged and emphasized. Students are given freedom to select a problem from a variety of sources. Students are required to plan a procedure, organize needed equipment, work with engineering situations related to their problem, and obtain and interpret data relative to the question posed in the problem. A comprehensive written report is required of one major project eath grading period.

Laboratory work does not necessarily supplement current classroom topics, although in many cases student choice of problems causes it to do so. An attempt is made to allow students to discover in their laboratory work how scientists define a problem and the procedures they use to obtain an answer to that problem.

Approximately one-fifth of the classroom time is used in laboratory work. Many students utilize study hall time and after-school hours to supplement their laboratory work.

OBJECTIVE: To design, run, and evaluate an experiment of the student's design using a problem from Waves and Wave Phenomena

TITLE: "A Problem Related to Waves and Wave Phenomena"

SOURCE: Teacher developed

Each student is required one minor lab in light and one minor lab in sound or general wave phenomena, with primary evaluative emphasis on a major investigation of the student's own design.

Examples are listed below.

OBJECTIVE: To provide an open-ended method of quantitatively evaluating the effect of tension, density, diameter, and Young's modulus on the velocity of a standing wave in a wire or string using a string vibrator

TITLE: "Factors That Affect the Velocity of a Wave in a Media"

SOURCE: Teacher developed

OBJECTIVE: To discover and examine quantitatively the effect of variables such as concentration, temperature, and other factors on the rotation of a plane of polarized light

TITLE: "Factors Affecting Optical Rotation"

SOURCE: Teacher student developed

Resources
Grades 11, 12
Physics S
Unit: Waves and Wave
Phenomena

Text Materials

Williams, Trinklein, and Metcalfe. Modern Physics. Holt, Rinehart, and Winston, 1976, pp. 223-376.

Films -- 16 mm

Electromagnetic Waves, PSSC -- Kent State Rental

Introduction to Optics -- Indiana University Film Rental

Introduction to the Cathode Ray Oscilloscope -- Indiana University Film Rental

Laser Light -- Indiana University Film Rental

Simple Waves, Bell Labs -- on loan from Modern Talking Pictures

Speed of Light in Air and Water, PSSC Series -- rented from Kent State

Films -- 8 mm Single Concept -- High School Learning Center

Optics Series

Ripple Tank Series

Transparencies

Wave and Optics Series -- Physics lab file

Record -- High School Learning Center

The Science of Sound, Bell Labs

Exemplary Activity
Grades 11, 12
Physics S
Unit: Waves and Wave Phenomena

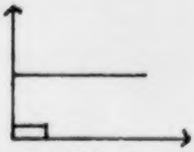
Reference:

"Factors That Affect the Velocity of a Wave in a Media," teacher developed, available in high school physics lab file in Room 132.

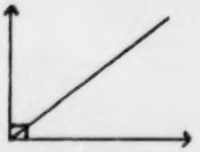
Evaluation Sample
Grades 11, 12
Physics S
Unit: Waves and Wave
Phenomena

Which of the following graphs (A-E) would show the relationship of questions 1-3?

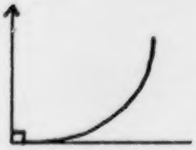
(A)



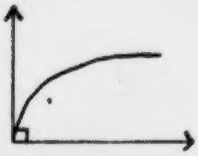
(B)



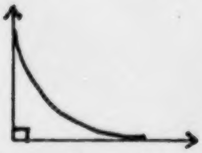
(C)



(D)



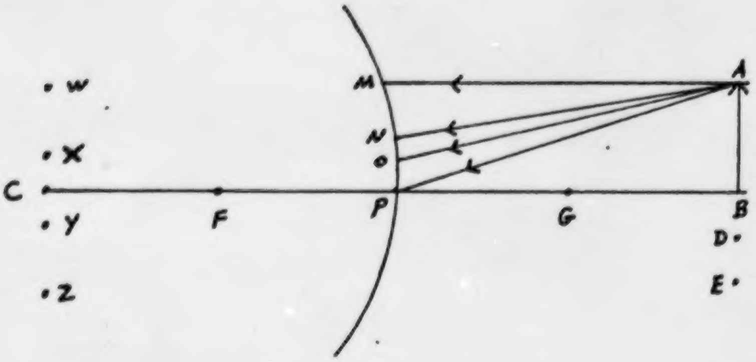
(E)



1. $D_i=f(D_o)$ for a plane mirror? (D_i= image distance from mirror, D_o= object distance from mirror.)

2. $A_r=f(A_i)$ for a plane mirror? (A_r= angle of reflection, A_i= angle of inc.)

3. $S_i=f(S_o)$ for a concave spherical mirror? (S_i= image distance from focal point, S_o= object distance from focal point.)



The curved line on the left represents a section through a spherical convex mirror. AB is the object, C is the center of curvature, and F is the focal point. The lines represent rays striking the mirror from the tip of the object. CB is the axis line. AM is parallel to PB. AB=WC=CZ=BE PC=PB
XC=CY=BD=OP

Complete items 4-7 using the above drawings and the laws of reflection. Use points from the drawing for answers. If no point applies, write none.

4. The reflected ray from O seems to come from point ____? Select a point left of mirror.

5. The reflected ray from M seems to come from point ____? Select a point left of mirror.

6. The reflected ray from N seems to come from point ____? Select a point left of mirror.

7. The reflected ray from P seems to come from point ____? Select a point left of mirror.

8. Using the information from the drawing on the previous page, imagine that you will stick a pin into the paper at the point on the axis CB where the image of AB will be located. State qualitatively where the pin will be placed, for example, "at C" or "left of C" or "between C and F" etc.

Assume the mirror of the drawing to be silvered on both sides. Then from the left side it is a concave mirror with FP the focal length = to f. Use an object AB that is 1/2 f tall. Answer #9 and #10 in terms of this object -- HEIGHT IN TERMS OF f.

9. How tall will the image be if AB is located twice the distance PC from the mirror?

10. How tall will the image formed be if the object AB is placed at C?

Unit Outline
Grades 11, 12
Physics S
Unit: Electricity and
Magnetism

I. Charge at Rest

- A. Elementary charge and electrification
- B. Potential difference and charge distribution of electric fields using the Faraday ice pail, Van DeGraff generator
- C. Capacitance

II. Direct Current Circuits

- A. Current sources
  - 1. Primary cells
  - 2. Secondary cells
  - 3. Generators
  - 4. Miscellaneous sources
- B. Ohm's Law
- C. Work and charge
- D. Heating effects, chemical effects, and power

III. Magnetism and Electromagnetism

- A. Magnetic theory -- domain theory and electrical effects
- B. Magnetic fields
  - 1. Field shapes and interactions
  - 2. Hysteresis and permeability
  - 3. Motor and generator effects based on field interactions -- motor and generator rules
- C. DC meters and Ohm's Law
- D. Motors and generators
  - 1. Motor effects and back emf
  - 2. Motor losses
  - 3. Motor types and windings
  - 4. Generator effects and motor effects
  - 5. Generator types and losses
- E. Inductance
  - 1. Inductors in a circuit
  - 2. Transformer effects
  - 3. Transformer losses

IV. A-C Circuits

- A. Power and effective values in an A-C circuit
- B. A-C meters
- C. Inductive reactance
- D. Capacitive reactance

E. Resonance
1. Inductance vs frequency
2. Capacitance vs frequency
3. Simple resonance
4. Selectivity and tuned circuits
a. Oscillator circuits
b. Selective detector circuits -- AM and FM signals

V. Electronic Devices

A. Vacuum tubes
1. Electro-thermal effects -- diode
2. Effect of charged grids -- triode, amplification
3. Vacuum tube circuits and effects
4. Cathode ray tubes -- oscilloscopes, TV
B. Transistor and transistor effects

Suggested Activities
Grades 11, 12
Physics S
Unit: Electricity and
Magnetism

The primary purpose of the physics laboratory is to develop problem-solving skills and provide students with hands-on experience in a variety of real problem solving. Individual project work is encouraged and emphasized. Students are given freedom to select a problem from a variety of sources. Students are required to plan a procedure, organize needed equipment, work with engineering situations related to their problem, and obtain and interpret data relative to the question posed in the problem. A comprehensive written report is required of one major project each grading period.

Laboratory work does not necessarily supplement current classroom topics, although in many cases student choice of problems causes it to do so. An attempt is made to allow students to discover in their laboratory work how scientists define a problem and the procedures they use to obtain an answer to that problem.

Approximately one-fifth of the classroom time is used in laboratory work. Many students utilize study hall time and after-school hours to supplement their laboratory work.

OBJECTIVE: To design, run, and evaluate an experiment of the student's own design, using a problem from Electricity and Magnetism

TITLE: "A Problem Related to Electricity and Magnetism"

SOURCE: Teacher developed

Each student is required one minor lab in magnetism and one minor lab in current electricity, with primary evaluative emphasis on a major investigation of the student's own design.

Examples are given below.

OBJECTIVE: To provide the student with a working knowledge of the use of voltmeters and ammeters in a simple circuit and to provide hands-on experience in simple resistance circuits

TITLE: "How to Read and Use the Welch Voltmeter and Ammeter"

SOURCE: Teacher developed

OBJECTIVE: To study the relationships among potential difference, current strength, and resistance throughout a simple network

TITLE: "Simple Networks"

SOURCE: Modern Physics, Lab Manual, p. 96.

OBJECTIVE: To determine the number of calories per joule of electrical energy

TITLE: "Electrical Equivalent of Heat"

SOURCE: Modern Physics, Lab Manual, p. 97.

OBJECTIVE. To investigate the use of Maxwell's cyclic currents and delta to wye transformation to solve actual complex and cubic circuits

TITLE: "Complex and Cubic Circuits"

SOURCE: Student project

Resources
Grades 11, 12
Physics S
Unit: Electricity and
Magnetism

Text Materials

"The Deforest Triode," *Scientific American*, March 1965.

Williams, Trinklein, and Metcalfe. *Modern Physics*. Holt, Rinehart, and Winston, pp. 377-580.

Films

A Magnet Lab, PSSC -- Rental

The Millikan Experiment, PSSC -- Rental

The Triode, PSSC -- Rental

When the Circuit Breaks -- Modern Talking Picture

Transparencies -- Physics lab file

Current Electricity Series

Magnetic Effects Series

Opaque Material

Photographs of iron filings in magnetic fields -- student project in instructor file

Exemplary Activity
Grades 11, 12
Physics S
Unit: Electricity and
Magnetism

Reference:

Williams, Trinklein, and Metcalfe. "Simple Networks," Modern Physics Lab Manual. Holt, Rinehart, and Winston, p. 96.

Evaluation Sample
Grades 11, 12
Physics S
Unit: Electricity and
Magnetism

____ 1. The inertia of a body tends to cause the body (A) to speed up (B) to slow down (C) to resist any change in its motion (D) to fall to earth (E) none of these.

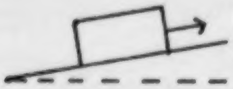
____ 2. A vector quantity can be distinguished from a scalar because it has (A) constant properties (B) direction (C) magnitude (D) force (E) length.

____ 3. A uniform meter stick weighing 0.40 nts can be balanced by a weight of 0.80 nts at the 100 cm mark if the fulcrum is placed at the point marked (A) 75 cms (B) 66.7 cms (C) 33.3 cms (D) 83.3 cms (E) 50 cms.

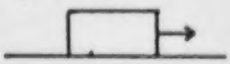
____ 4. The number 2.5×10^5 is equal to (A) 25,000 (B) 25 (C) 0.00025 (D) 2.5 (E) 250×10^3 (F) none of these.

____ 5.

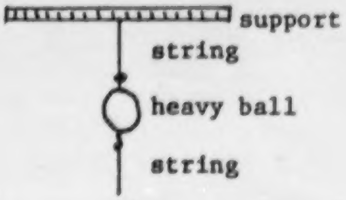
(a)



(b)

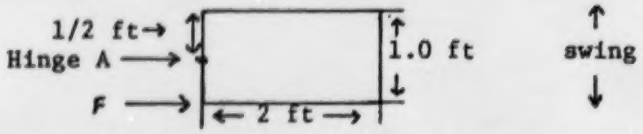


A heavy wooden block is being drawn over a steel plate (a) with the plate inclined and (b) with the plate horizontal. The force required to overcome friction in case (b) as compared to case (a) is (A) the same (B) greater (C) less (D) greater for some angles and less for others.



____ 6. A heavy ball is suspended by means of a string and another string is attached to the lower part of the ball. A quick jerk on the lower string breaks it below the ball. A slow pull on the lower string breaks the string above the ball. The first result occurs because (A) the force is too small to move the ball (B) to every action there is an equal and opposite reaction (C) the inertia of the ball is not overcome (D) friction holds the ball back (E) none of the above.

Items 7-9: A uniform piece of board weighing 10.0 lbs is 2.0 ft long and 1.0 ft wide. It is held (free to swing in a vertical plane, in the plane of the paper) by a hinge at A.



____ 7. The force F required to hold it in equilibrium in the position shown is (A) 10 lbs (B) 5.0 lbs (C) 20 lbs (D) 7.5 lbs.

____ 8. The force acting at hinge A when the board is in the position above is (A) 15 lbs (B) 30 lbs (C) $\sqrt{500}$ lbs (D) $\sqrt{30}$ lbs (E) $\sqrt{400}$ lbs.

____ 9. The above force at the hinge makes an angle with the horizontal whose tangent is (A) 1 (B) 0.3 (C) 1.72 (D) 0.5 (E) 0.1.

____10. If the distance between two electric charges is changed from 3.0 cm to 9.0 cm, the force between them is now (A) 1/27 as great (B) 1/9 as great (C) 1/6 as great (D) 1/4 as great (E) none of these.

____11. The capacitance (C) of a capacitor may be increased by (A) applying a greater voltage across it (B) moving the plates farther apart (C) reducing the area of the plates (D) using glass instead of air as the dielectric (E) none of these.

____12. The unit used to express a flow of charge per unit time is called (A) a coulomb (B) an ampere (C) a kilowatt-hour (D) a volt (E) an oersted (F) none of these.

____13. A cell whose open circuit emf is 1.5 volts is delivering a current of 1.0 ampere. (A) The internal resistance of the cell is 1.5 ohms. (B) The external resistance of the circuit is 1.5 ohms. (C) The sum of the internal resistance of the cell and the external resistance is 1.5 ohms. (D) The difference between the external resistance and the internal resistance of the cell is 1.5 ohms. (E) none of these

____14. If the resistance of an electric circuit is doubled, other factors remaining the same, the current is (A) doubled (B) remains the same (C) halved (D) is 1/4 as great (E) none of these.

____15. It is better to send 10,000 K.W. of electric power long distances at 10,000 volts rather than at 220 volts because (A) the heating effect is less for any given wire (B) the resistance is less at high voltage than at low voltage (C) insulation is more effective at the higher voltage (D) the IR drop along the wires is greater at higher voltage (E) it is more practical to generate the higher voltage in the generator than the lower one.

____16. Alternating current is not suitable for (A) running electric motors (B) heating electric toasters (C) transmitting electric power (D) charging storage batteries (E) operating radios (F) electroplating (G) two of the above (H) none of the above.

____17. To increase the range of a D.C. ammeter, it is equipped with (A) a high resistance in series (B) a low resistance in series (C) a high resistance shunt (D) a low resistance shunt (E) none of these.

____18. An emf may be produced in a wire in all ways but (A) moving a magnet in a coil of wire (B) moving a coil of wire in a magnetic field (C) making an expanding electromagnetic field cut across a coil of the wire (D) moving the coil of wire in the earth's magnetic field (E) having the wire wound around a wire that is carrying a constant direct current.

____19. What type of generator produces a greater emf across the load when the load is increased? (A) compound wound (B) series wound (C) shunt wound (D) induction wound (E) none of these

____20. A d-c ammeter has a resistance of 12.0 ohms and gives a full-scale deflection for a current of 1.00×10^{-2} ampere. The resistance to be placed in series with this instrument to change it to a voltmeter giving a full-scale reading of 3.00 volts is (A) 134 ohms (B) 182 ohms (C) 288 ohms (D) 365 ohms (E) none should be placed in series but should be placed in parallel.

____21. Back emf in a motor limits its (A) top rpm (B) torque (C) efficiency (D) ability to do work at a low rpm (E) all of these (F) none of these.

22. Draw a cross-sectional diagram of a conductor, which is part of a closed circuit, that is passing upward through a magnetic field that has north on the left. The conductor should appear as a circle in your diagram. Draw in all magnetic fields and their interactions, and the direction of the electron flow.

23. Describe the important events that take place when we place a large mechanical load on a electric motor that slows the motor down below its rated rpm. Why do these events take place?

24. Discuss the working of a transformer. Include the following in your discussion: how the power is transmitted from the primary to the secondary; losses and their causes; and a diagram of a step up transformer, labeled of course.

Unit Outline
Grades 11, 12
Physics S
Unit: Energy, the Environment, and Our Economy

This is an introductory unit to be used as a general overview of energy, environmental, and economic problems. It will require one to two weeks of time, depending on student interest and involvement. Further study of individual concepts, e.g., nuclear reactors and wind power, will be considered in detail at appropriate times during the topical study of a conventional physics program based on Modern Physics by John E. Williams, et al., 1976 edition. A final wrapup and reevaluation of energy problems and the impact of their solutions will be made near the end of the year.

The purposes of this unit are:

1. To cause students to be aware of the existence of an energy problem;

2. To provide the students with some insight into the complex interactions among energy, ecology, and economics through cost/risk/benefit analysis;

3. To make students aware of the magnitude of exponential growth in both population and energy use;

4. To promote student interest in physics by demonstrating that physics is the science of energy and that decisions related to the energy problem should be based upon sound physics principles;

5. To provide an ongoing motivational theme and unity of purpose for the study of specific topic areas related to energy production and utilization throughout the physics program; and

6. To begin the development of an understanding of the difference between theory and practice and to demonstrate the need for economic considerations in engineering.

I. Statement and Discussion of General Course Goals

   A. Critical thinking
      1. Ability to think critically
      2. The method of science
      3. The nature and validity of data
      4. Willingness to evaluate critically all ideas -- social, political, and economic
   B. Awareness of physics in our environment -- physics as nature study
      1. Aerodynamics of flight in birds and bees
      2. Energy conversion in living systems
      3. Behavior of falling objects
   C. College Preparatory Relevance
      1. Science majors
      2. Nonscience majors

II. Discussion and Description of General Topical Areas in Physics

- A. Measurement
- B. Statics
- C. Kinematics
- D. Dynamics

III. Matter -- Definition in Terms of Inertia and Relationship to $\vec{F} = M\vec{A}$

- A. Demonstrate $\vec{F} = M\vec{A}$ in a qualitative manner using carts, pullies and weights.
- B. Discuss measurement of mass with and without gravity.
- C. Relate mass and weight through g.
    - 1. Students compute weight of 170 lb person on various bodies in solar system with various g given in English and metric units. Find weight in lbs and newtons.
    - 2. Students compute gravitational force between two students in room using $F = G\,{}^{m}1{}^{m}2/S^{2}$. Relate magnitude of F to known forces and weights. (Emphasize factor-label computations.)
- D. Nongravitational methods of measuring mass -- explosion of dynamics carts, use of mechanical oscillator, and use of inertial balance
    - 1. Demonstrate explosion of dynamics carts using unequal masses of several magnitudes.
    - 2. Discuss problems of docking "weightless" spacecraft in orbit and relate to inertia and $\vec{M}V$.
- E. Introduce momentum as a vector quantity.
    - 1. Demonstrate inelastic collisions using the air track, mass carts, velcro, and electronic timer, thus illustrating conservation of MV.
    - 2. Mathematically analyze the two-body collisions.
- F. Discuss density and compare types with a varying g -- mass density vs weight density.

IV. Energy -- Define Energy in Both a Formal and an Operational Mode, $W = \vec{F}\cdot\vec{S}$.

- A. Discuss energy types or forms and their interrelationships via work transfer and radiation.
    - 1. Define kinetic energy in MKS units ($K_E = 1/2MV^2$) and as a scalar quantity dependent on mass and gross motion.
        - a. Show the transfer relationship between gross and molecular K_E relative to thermal energy and sound.
        - b. Demonstrate the conversion of K_E to thermal energy by pounding a soft metal with a hammer.
    - 2. Define potential energy.
        - a. Relate to position and work.
        - b. Relate to gross internal condition.
        - c. Analyze the energy stored in a long bow under stress.

(2) d. Analyze the molecular internal condition relative to the chemical potential of gasoline and the latent heat of vaporization of water.
B. Discuss energy transfer systems and the conservation of energy.
  1. Demonstrate elastic vs inelastic collisions with dynamic carts.
  2. Analyze energy transfers in a complex system (the automobile).
  3. Analyze energy transfers via radiation, waves, particles, convection, and conduction using a radiometer, slinky spring, and thermal conduction materials.
C. Define nuclear energy.
  1. Explain fission (chain reaction).
  2. Explain fusion.
  3. Relate the mass defect curve and energy production.

V. Problems Associated With Exponential Growth in Population and Energy Use

A. Current energy use
  1. Amount necessary for human life as we know it in the USA
  2. Amount required for a reasonable standard of living
  3. Amount strictly unnecessary
B. The energy gap
  1. Energy production
  2. Energy consumption
C. Conserving energy
  1. Promoted in transportation relative to fuel cost, law, rationing, education, and mass transit
  2. Promoted in residential use relative to fuel cost, rationing, insulation, plant efficiency, and education
  3. Promoted in commercial and industrial use relative to fuel cost, rationing, insulation, plant efficiency, and education
  4. Promoted in agriculture relative to fuel cost, rationing, insulation, plant efficiency, and education
D. Increasing energy supply
  1. Oil and gas
    a. Decontroling prices, the problems and effects -- political, social, and economic
    b. Increasing imports, the problems and effects -- political, social, and economic
    c. Altering environmental standards, the problems and effects
    d. New technological development and new recovery systems
  2. Coal
    a. Surface and deep mining
      (1) Economic, environmental, and safety problems
      (2) Reclamation and cost
    b. Environmental problems of burning coal
      (1) SO_x, fly ash, cost of stack scrubbers
      (2) importance of cost/risk/benefit analysis

3. Nuclear — light water
    a. Environmental problems -- thermal, radiation, waste disposal
    b. Safety -- explosions, meltdown, contamination, radiation
    c. Cost, fuel availability, reliability
4. Nuclear -- breeder
    a. Environmental problems -- thermal, radiation, waste disposal
    b. Safety -- explosions, meltdown, contamination, radiation
    c. Cost, fuel availability, reliability
5. Nuclear fusion
    a. Plenty of fuel
    b. Technical problems
    c. Environmental problems
6. Solar
    a. State of technology and problems
    b. Cost effectiveness
    c. Environmental impact
7. Geothermal
    a. State of technology and problems
    b. Cost effectiveness
    c. Environmental impact
8. Tides and other sources
    a. State of technology and problems
    b. Cost effectiveness
    c. Environmental impact

OBJECTIVE: To relate mass and weight through g by computing weights on various bodies in the solar system

TITLE: "Weights on Other Planets"

SOURCE: Teacher developed

OBJECTIVE: To relate mass and weight through g by computing the gravitational force between two students in the classroom

TITLE: "Student Attraction"

SOURCE: Teacher developed

OBJECTIVE: To apply the principles of inertia and momentum in the analysis of two-body collisions

TITLE: "Inelastic Collisions Using the Air Track"

SOURCE: Teacher developed

OBJECTIVE: To analyze the energy stored in a long bow under stress, the work the bow does on the arrow, and the energy transfers involved with the arrow in flight

TITLE: "Energy Analysis of the Long Bow"

SOURCE: Teacher developed

OBJECTIVE: To analyze the energy transfers that occur as you start up, drive, and stop a car

TITLE: "Energy Transfers in the Automobile"

SOURCE: Teacher developed

OBJECTIVE: To use nuclear mass defect to determine nuclear energy production, and to compare nuclear fuels with chemical fuels

TITLE: "Putting a Truck in Orbit"

SOURCE: Teacher developed

OBJECTIVE: To enumerate the results of growth with various compounding factors over varying lengths of time

TITLE: "Growth Compounded"

SOURCE: Teacher developed

OBJECTIVE: To apply the procedure of cost/risk/benefit analysis to the automobile, and to become familiar with how this procedure can be applied to energy and environmental problems

TITLE: "Cost/Risk/Benefit Analysis"

SOURCE: Teacher developed

Resources
Grades 11, 12
Physics S
Unit: Energy, the Environment, and Our Economy

Text Materials

Williams, John E.; Trinklein, Frederick E.; and Metcalfe, H. Clark. Modern Physics. Holt, Rinehart, and Winston, 1976.

Films

Challenge of the Future -- ERDA

Energy: Choices, Options, Decisions -- Columbus and Southern Ohio Electric

Three E's: Energy, Environment, Economics -- Exxon Oil Co.

Transparencies -- Physics File

Energy Consumption Versus Production Curves

Energy Use by Sector

Energy Use Cartoon

Energy Use in the Transportation Sector

Fission

Fusion

Mass Defect Curve

Population Growth

Residential Heat Loss

Tapes -- Physics Lab

Anderson tape

Exemplary Activity
Grades 11, 12
Physics S
Unit: Energy, the Environment, and Our Economy

OBJECTIVE: To apply the procedure of cost/risk/benefit analysis to the automobile, and to become familiar with how this procedure can be applied to energy and environmental problems

MATERIALS AND EQUIPMENT: None

PROCEDURE:

Consider the common automobile. Auto parts and systems occasionally fail. These failures may be divided into two major areas:

1. Those that cause expense and inconvenience (large or small); and
2. Those that may cause injury and death to both passengers and innocent bystanders.

List ten or more of the most common failures that come to your mind in each of these categories.

Estimate the likely range in cost (lowest to highest) in money, time, and life of each of these failures.

Estimate the likelihood of each of these events occurring (in terms of thousands of miles) with average maintenance.

Show a low cost method of reducing the probability or severity of each of these problems.

Indicate the cost and method of reducing these problems to zero, if possible, or very near zero, if not.

Considering the likelihood and severity of the possible failure, which, if any, of the above solutions would you voluntarily apply to YOUR car? Which of these should the law require of all new cars? of all old cars?

Be prepared to explain and/or defend to the class your own position on these solutions on the basis of cost in effectively reducing risk and increasing benefit.

Is there a difference between what you would do as a voluntary option and what you would require by law? Should there be? Why or why not?

If money is limited, how will you spend it to prevent auto failure?

Example: Dead Battery

A car with 20,000 miles on the odometer will not start. This situation might be a minor problem with minimal cost and inconvenience for a multicar family if the breakdown occurs near home. However, if the breakdown occurs in the wilds, especially in bad weather, the same situation may be a major problem.

One low cost solution to minimize the inconvenience of the breakdown and/or prevent it entirely would be to carry jumper cables in the car and clean and check the battery every six months. A high cost solution would be to use a dual battery system and maintain it on a monthly basis. The choice is a personal decision to which you can apply cost/risk/benefit analysis.

Discuss how this type of cost/risk/benefit analysis can be used in energy and environmental problems.

Example:

NO_x emissions from automobile exhausts seem to be a problem. What percent of NO_x in the air comes from auto exhausts in an urban versus a rural environment? What are the short term and long term effects of NO_x at various concentrations? How would the air quality be improved if NO_x auto emissions were reduced 50%? 90%? 99%? 100%? How would this affect the quality of life over the short term? over the long term? How does the cost in terms of money, fuel, and other problems change from the 50% through the 100% reduction? At what level, if any, could this money be better spent to improve health in some other way?

Evaluation Sample
Grades 11, 12
Physics S
Unit: Energy, the Environment, and Our Economy

Reference:

Unit test on Energy, the Environment, and Our Economy. Available in the high school physics test file in Room 132.

CURRICULUM GUIDE EVALUATION FORM

The curriculum guide is an aid that helps teachers formulate and implement instructional practices that assist students in attaining district goals. As an integral part of the curriculum, the guide should be subjected to continuous review and revision. To help this review process, a standing committee will be established, and teachers will be made aware of the evaluation criteria and channels for communicating relative to the guide's format and effectiveness.

Evaluative Criteria/Questions

		Yes	No	Somewhat
1.	Is the philosophy in keeping with the best thinking regarding the discipline?			
2.	Are the instructional objectives appropriate?			
3.	Is the scope and sequence useful in instructional planning?			
4.	Does the guide contain sufficient suggested activities?			
5.	Are there sufficient alternative activities from which choices may be made?			
6.	Do the open-ended activities lead to exploratory learning for students?			
7.	Are the activities realistic with respect to physical and other limitations?			
8.	Is the content accurate?			
9.	Is the guide content up-to-date?			
10.	Is the content of the guide readily understandable?			
11.	Can the various sections of the guide be located quickly?			

Please send this questionnaire to the assistant superintendent for Curriculum, Instruction, and Planning. Your input will be forwarded to the chairperson of the standing committee.

Questionnaire results will be used to revise and update the curriculum guide.

Thank you for your continued cooperation.

CURRICULUM GUIDE EVALUATION FORM

The curriculum guide is an aid that helps teachers formulate and implement instructional practices that assist students in attaining district goals. As an integral part of the curriculum, the guide should be subjected to continuous review and revision. To help this review process, a standing committee will be established, and teachers will be made aware of the evaluation criteria and channels for communicating relative to the guide's format and effectiveness.

Evaluative Criteria/Questions

	Yes	No	Somewhat
1. Is the philosophy in keeping with the best thinking regarding the discipline?	____	____	________
2. Are the instructional objectives appropriate?	____	____	________
3. Is the scope and sequence useful in instructional planning?	____	____	________
4. Does the guide contain sufficient suggested activities?	____	____	________
5. Are there sufficient alternative activities from which choices may be made?	____	____	________
6. Do the open-ended activities lead to exploratory learning for students?	____	____	________
7. Are the activities realistic with respect to physical and other limitations?	____	____	________
8. Is the content accurate?	____	____	________
9. Is the guide content up-to-date?	____	____	________
10. Is the content of the guide readily understandable?	____	____	________
11. Can the various sections of the guide be located quickly?	____	____	________

Please send this questionnaire to the assistant superintendent for Curriculum, Instruction, and Planning. Your input will be forwarded to the chairperson of the standing committee.

Questionnaire results will be used to revise and update the curriculum guide.

Thank you for your continued cooperation.

BIBLIOGRAPHY FOR THE PREPARATION OF THE CURRICULUM GUIDE

Ausubel, David P. "Some Psychological Considerations in the Objectives and Design of an Elementary School Science Program," Science Education, Vol. VII, No. 3, April 1963, pp. 278-284.

Cantrell, Sue Rowe, and Caldwell, Loren T. "A Selection and Evaluation of Phvsics and Chemistry Concepts to Be Used in the Seventh and Eighth Grade Science Program," Science Education, Vol. VII, No. 3, April 1963, pp. 264-270.

Course Goals in Biological and Physical Science, K-12. Tri-County Goal Development Target, Multnomah County Intermediate Education District, Portland, Oregon, 1973.

Elementary Science Guide, K-7, Virginia State Department of Education, ED 083 044. Division of Elementary Education, Richmond, Virginia, 1972.

Janke, Delmar L., and Pella, Milton O. "Earth Science Concepts List for Grades Eight Through Twelve, Curriculum Construction and Evaluation," Journal of Research in Science Teaching, Vol. 9, No. 3, 1972, pp. 223-230.

Novak, Joseph D. "The Role of Concepts in Science Teaching," Analyses of Concept Learning. New York Academic Press, 1966.

"Program Objectives and Scientific Literacy," Prism II, Vol. 2, Nos. 3 and 4, Center for Unified Science Education, 1975.

Science: A K-8 Scope and Sequence. Staff Utilization for Continuous Progress Education Project, E.S.E.A. Title III, Scottsdale Public Schools, Phoenix, Arizona, 1973.

Taba, Hilda. Curriculum Development, Theory, and Practice. Harcourt, Brace and World, Inc., 1962.

Theory Into Action. National Science Teachers Association Committee on Curriculum Development, 1964.